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Properties of Gas Discharge in Field of Strong Acoustic Wave

927J0259A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 62 No 5, May 92 (manuscript received 12 Nov 91) pp 723-725

[Article by M. A. Antinyan, G. A. Galechyan, A. R. Mkrtchyan and L. B. Tavakalyan, Institute of Applied Physical Problems, Armenian Academy of Sciences, Yerevan]

[Abstract] An experimental study was made of the effect exerted by a sound wave propagating along a positive column on gas discharge parameters. The behavior of a longitudinal electric field, gas temperature in a discharge, temperature and concentration of electrons in a sound wave field is described. The study was centered on modulations of the discharge current, concentration and temperature of electrons caused by an acoustic wave. The experimental study also dealt with the phase shift between oscillations of the electron and ion components of plasma and an acoustic wave in a nitrogen discharge. Experimental measurements were made at pressures 10-60 mm Hg and in currents 40-90 mA in a tube 9.8 cm in diameter. Acoustic wave intensity was varied from 60 to 90 db. With an increase in acoustic wave intensity the phase shift decreases, whereas with an increase in nitrogen pressure in the discharge it increases. The influence of admixtures of oxygen, argon and helium to a nitrogen discharge on current modulation intensity was determined. The sound effect in a nitrogen discharge was experimentally investigated. The conditions under which sound completely eliminates the hysteresis region on the current-voltage characteristics of the discharge and causes its complete decontraction also were determined. References: 14: 10 Russian, 4 Western.

Compression of Solid Organic Acids and Anhydrides in Shock Waves

927J0205B Moscow KHIMICHESKAYA FIZIKA in Russian Vol 11 No 4, Apr 92 (manuscript received 14 Jun 91) pp 557-562

[Article by R. F. Trunin, M. V. Zhernokletov, V. V. Dorokhin and N. V. Sychevskaya; UDC 532.593]

[Abstract] During recent years data has been obtained on the shock compressibility of numerous (mainly fluid) compounds constituting different classes of organic matter. The authors have been working on new methodological approaches and on broadening the classes of experimentally investigated matter. New data are given on the shock compressibility of a number of solid organic substances: six acids (tartaric, succinic, glutaric, maleic, palmitic, phthalic) and three anhydrides (succinic, phthalic and myristic). The shock compression pressure was 80 GPa. Conclusions are drawn concerning the general properties characteristic of the behavior of the investigated substances of one group or another under shock compression. The registered experimental data are given in a composite table and in two figures in D-U coordinates (D is the velocity of shock wave propagation, U is the mass velocity of movement of matter behind the shock wave front). The following were the principal results of this research: there is a similarity of the shock adiabats for organic compounds belonging to the same homologic series; there is a similarity of the shock adiabats of the acids and the corresponding anhydrides; there are jumplike changes in the kinematic and thermodynamic parameters on the shock adiabats of organic compounds in whose structural formula the benzene ring is present. Figures 2; references 7: 3 Russian, 4 Western.

Equations of Hydrodynamics for Porous Media With Fractal Geometry of Void Space Structure

927J0242A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 62 No 3, Mar 92 (manuscript received 25 May 91) pp 405-410

[Article by A. V. Malshakov, Tyumen Industrial Institute; UDC 532.546]

[Abstract] Equations of multiphase filtration are first derived for a medium such as one where the wetting phase displaces the not wetting phase, considering a fractal void space with Hausdorff-Bezikovich dimensionality d_f immersed in a continuous medium with dimensionality $d \geq d_f$, $d = 2,3$). Flow with cylindrical symmetry ($d = 2$) or spherical symmetry ($d = 3$) is considered, all flow parameters in both cases being functions of time and of the radial coordinate. The law of mass conservation in the integral form together with generalized Darcy's equation and an expression for the pressure difference yields, under the condition of constant resultant filtration rate, the Rappoport-Lies equation for a fractal porous medium. Considering next that the total mass transfer in a porous medium consists of a convection component and a diffusion component, an equation of motion is obtained for an impurity in the stream of an otherwise homogeneous liquid, this equation being readily modifiable so as to also include absorption. A mathematical model is then constructed to describe capillary impregnation of a porous material for displacement of one liquid inside it with another, specifically displacement and extraction of petroleum by water in the percolating mode from a medium with fractal geometry of the void space. The counterflow of two liquids, with zero net velocity of the two-phase flow, is in this model described by a quasilinear partial differential equation of the parabolic kind with appropriate initial and boundary conditions. The displacement process is here treated as formation of an infinite cluster of pores saturated with the wetting phase (water) or or with the not wetting phase (petroleum), depending on the level of saturation with which is much higher. This equation is solved separately for the level of saturation with each liquid phase. References 26.

Supersymmetry and Problems in Acoustics

927J0208A Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 90, No 3, Mar 92 (manuscript received 25 Jan 91) pp 407-411

[Article by A. V. Badanin, B. P. Belinskiy, K. N. Ilinskiy and V. M. Uzdin, Leningrad State University]

[Abstract] The concepts of supersymmetry are now finding wide application in quantum mechanics, nuclear physics and physics of unordered media. This article examines an acoustic problem with a supersymmetric structure and it is demonstrated that the supersymmetry property is related to the group structure of an unperturbed system. After examining the very simple algebra of supersymmetry arising in supersymmetric quantum mechanics (a standard example of such a supersymmetric system is an electron in a permanent magnetic field, a model in which supersymmetry is related to the group symmetry E(2) of motion of a free electron on a plane), a study is made of the problem of oscillations of a compressible fluid bounded by a rectilinear plate on one side and an acoustically soft boundary on the other. The supersymmetric structure of the resolving operator is ascertained. The common character of the properties of the solution and solution of the quantum mechanical problem of an electron in a magnetic field caused by the presence of supersymmetry is demonstrated. The relationship between supersymmetry and the group symmetry of the problem is explained. References 11: 6 Russian, 5 Western.

Full Transmission of Acoustic Waves Through Metal or Superconducting Interlayer in Piezocrystals

927J0201A Moscow KRISTALLOGRAFIYA in Russian Vol 37 No 2, Mar-Apr 92 (manuscript received 21 Oct 91) pp 284-290

[Article by V. I. Alshits and V. N. Lyubimov, Crystallography Institute, USSR Academy of Sciences; Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov; UDC 548.1]

[Abstract] With the simultaneous incidence of several acoustic waves having a common incidence plane, identical frequencies and the same projections of the wave vectors onto the plane of the interlayer, on a thin metal interlayer in piezoelectric material it is possible to select such a relation between their amplitudes and phases with which the interlayer becomes ideally "transparent": the incident waves freely pass through it, whereas all the remaining modes (reflected, refracted and inhomogeneous) completely disappear. The "transparency" condition is determined by the requirement that the total electric potential of all the waves incident on the plane of the interlayer becomes equal to zero. A similar phenomenon should also exist in a piezomagnetic material with a superconducting layer which also becomes "transparent" if the total magnetic induction component in the incident modes normal to the interlayer becomes equal to zero on this same plane. By the choice of only one scalar parameter (the ratio of the complex amplitudes of the incident waves) the complex picture determined by the superposition of a large number of reflected, refracted and inhomogeneous waves is radically simplified and is reduced to the simple transmission of incident waves through the interlayer. The total wave field of the remaining waves disappears, that is, a sort of "coherent interference" is seemingly observed in which the total amplitudes of the corresponding equivalent partial waves become equal to zero simultaneously. Figures 3; references: 8 Russian.

On One Automodel Soliton

927J0233B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 33 No 1, Jan-Feb 92 (manuscript received 4 Mar 91) pp 107-108

[Article by P. V. Yelyutin, Quantum Radiophysics Department, Moscow University; UDC 530.18]

[Abstract] An automodel solution in a soliton form is obtained for the Cortevega-de Friz equation with an additional term which considers nonlinear dissipation. The solution retains its form in propagation with changing parameters. Previously obtained automodel solutions for the Cortevega-de Friz equation described waves with an amplitude and/or frequency increasing without limit, and were far from solitons. Figure 1; references 4 (Russian).

Experimental Study of Interaction of Converging Axisymmetric Shock Waves With Sharp Cone and With Blunt Cone in Supersonic Stream

927J0150C Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 5, Sep-Oct 91 (manuscript received 4 Dec 90) pp 177-182

[Article by A. V. Krasilnikov, Moscow; UDC 533.6.011.72]

[Abstract] An experimental study was made concerning interaction of converging axisymmetric shock waves with a sharp cone and with a blunt cone in a supersonic air stream flowing through a wind tunnel. The air stream, generated in the antechamber under a pressure of 6 atm or 10 atm, entered the wind tunnel at a velocity of Mach 4.57 and was immediately compressed in a convergent nozzle generating shock waves. Tests were performed with two such nozzles having a 10° and a 20° convergence angle respectively. These nozzles were two conically hollow cylinders, both having a 178 mm outside diameter and keen front edges but each having keen front edges but each having a differently converging (10° and 20° inside duct. They were mounted in the first stage at the front end of the wind tunnel, one at a time permanently for each test. The test model, mounted at

the exit end of the wind tunnel coaxially with any given cylinder, was a cone consisting of a hollow frustum and an extension nose in front. The frustum, with a 38 mm outside diameter at the center, widened at a 14° angle in the direction of shock wave propagation. Tests were performed with two extension noses, one with a sharply pointed tip and one with the tip blunted spherically to a 4 mm radius. The cone, with any of the two nozzles, was movable along the axis so that the length of the test section from nozzle (cylinder) entrance to base of the the test cone, and thus also the distance from nozzle exit to tip of cone (nose), could be varied in 10 mm steps: the length of the test section with the 10° convergent nozzle over the 440-200 mm range and the length of the test section with the 20° over the 390-150 mm range. Interaction of shock waves and the test cone along the lateral surface was tracked by visualization of the flow pattern with the aid of an IAB 451 shadowgraph and by pressure measurements with ten DMI gages, the latter having been installed through 1.2 mm wide drain holes cut 15 mm, 35 mm, 55 mm, 75 mm, and 95 mm from the base of the cone in two rows of five along the top meridian and the bottom meridian respectively. The results of the experiment, each of the two cone extension noses having been tested with each of the two convergent nozzles, reveal how blunting the cone tip alters that interaction. The results are inconsistent with the Courant-Friedrichs theory. Inasmuch as this theory and all other known theories of conical flow are based on the assumption of an ideal fluid, such a fluid not being realizable in practice, that inconsistency is attributed to deviation of the real gas from an ideal one. The author thanks Yu.M. Lipnitskiy for formulating the problem and Ye.N. Bogachev for assistance in designing the experiment. Figures 5; references 10.

Evolution of Shock Waves in Polydisperse Gaseous Suspensions With Nonuniform Particle Concentration Distribution

927J0150D Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 5, Sep-Oct 91 (manuscript received 20 Apr 90) pp 183-190

[Article by A. G. Kutushev and U. A. Nazarov, Tyumen; UDC 533.6.011.72:532.529]

[Abstract] Propagation of shock waves through a gaseous suspensions of a polydisperse and thus nonhomogeneous solid phase, specifically one consisting of two very different size fractions with an initially nonuniform concentration distribution is analyzed in accordance with conventional mechanics of continuous multiphase media. All particles of both fractions are assumed to be spherical and their diameters as well as the distances between neighboring ones to be much smaller than the distances over which the flow characteristics change appreciably. The analysis is based on five one-dimensional partial differential equations of kinetics for each of the three phases (gas: $i = 1$; solid fractions: $j = 2,3$), one equation of state for a perfect gas, and one equation of state for each of two the fractions of incompressible solid particles. The system of equations is closed by laws of thermal and aerodynamic interactions between each solid fraction and the gas, these laws being formulated so as to involve four dimensionless groups: N_{Nu}, N_{Pr}, N_{Re}, N_{Ma}. The problem becomes a Cauchy problem for a system quasi-linear partial differential equations with appropriate initial conditions for densities, velocities, temperatures, and pressure in the $-\infty < x \leq x^*$ region corresponding to a stepwise perturbation of the gas by a shock wave at time $t = 0$. The state of the gas in that $-\infty < x \leq x^*$ region behind the shock wave is described by Rankine-Hugoniot equations. For a numerical analysis of the evolution of a shock wave in that region after time $t = 0$, all variables and parameters in the equations of motion, state, and interactions are nondimensionalized in accordance with the similarity principle. The equations of motion are then integrated numerically by the method of large particles, boundaries of large-particle and small-particle clusters being localized for precise tracking of their motion. Such a numerical evaluation has been made for a shock wave of an intensity corresponding to a velocity Mach 2.95 in air carrying two fractions, 60 μm and 360 μm, of quartz sand. Figures 5; references 7.

Use of EPR-Spectroscopy for Study of Self-Propagating High-Temperature Fusion

927J0126A Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 27 No 5, Sep-Oct 91 (manuscript received 5 Oct 90) pp 91-94

[Article by Ye. G. Klimchuk, K. G. Gazaryan, and A. G. Merzhanov, Yerevan; UDC 536,4+541.12; 542.9+66.091]

[Abstract] EPR-spectroscopy of a self-propagating high-temperature fusion involving conversion of radical particles in a mixture of organic reactants was performed on a 1:1 mixture of analytically pure 8-quinolinol C_9H_7NO and commercially pure chloramine-B $C_6H_5SO_2NaCl \times 3H_2$, the latter having been dried over a desiccant at a 313 K temperature. The advantages of this combination of organic substances are that experimentation with them does not require an inert atmosphere, that the critical diameter for their entering into a reaction is fairly small (about 6 mm) despite the low combustion rates and temperature, and that no gas evolves during the reaction. The mixture of two powders in the $d < 0.2$ mm grain size fraction was compacted under a pressure of 10 atm into 7-10 cm high cylinders 9-10 mm in diameter. Reaction was initiated by dropping on such a cylinder a copper cylinder also 9-10 mm in diameter, after the latter had been preheated in a furnace to about 400 K. The cylinder-reactor, inside a thin quartz tube, was then passed through the spectrometer cavity until the reaction had run its course to nearly 100 percent completion. Both combustion rate and combustion temperatures at the fusion front were measured conventionally with thermocouples, the EPR spectra were recorded with a Varion E-104A instrument operating at a frequency of

about 9 GHz, the evolution of EPR signals in a constant magnetic field was tracked with a KSP-4 recording instrument, and the temperature profile in the fusion wave was determined on the basis of differential thermal analysis in $\delta T/\delta t,T$ coordinates. The four products of this self-propagating high-temperature reaction are $C_9H_7NO_2$ x H_2O + $C_6H_7SO_2NH_2$ + NaCl + H_2O, according to the results of infrared spectroscopy, NMR-spectroscopy, and X-ray phase analysis. The results of EPR-spectroscopy not only confirm this composition of the reaction products but also indicate the role of radical particles in such a solid-state reaction phase and yield data on the paramagnetic characteristics of the reaction products. Figures 3; references 7.

Formation of Ultrafine-Disperse Diamond Carbon Phase During Detonation of Heterogeneous Mixtures

927J0126B Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 27 No 5, Sep-Oct 91 (manuscript received 20 Nov 90) pp 136-140

[Article by I. Yu. Malkov, Novosibirsk; UDC 534.222.2: 553.81:54-114]

[Abstract] An experimental study concerning formation of an ultrafine-disperse diamond phase during decomposition of fluid organic mixtures is being conducted, in the latest experiment various organic fluids having been added to fill porous bulky octogen. Such a mixture was placed inside a hermetic steel chamber, the latter having been filled with an inert gas so as to prevent graphitization of the diamond. Fifteen different organic fluids were tested: saturated aliphatic hydrocarbons (hexane, decane, tetradecane), alcohols (pentanol, octanol, glycol, glycerol), and other derivatives (acetonitrile); unsaturated aliphatic alcohols (allyl alcohol, propargyl alcohol) and other derivatives (allylamine); aromatic hydrocarbons (benzene) and derivatives (benzyl alcohol, nitrobenzene, aniline). The velocity of detonation waves propagating through octogen alone D_{octo} and through octogen with liquid filler D_{mix} was measured, for an evaluation of the dependence of the difference $\Delta D = D_{mix} - D_{octo}$ on the speed of sound in the fluid additive. This dependence was found to be direct and linear for all filler fluids, but much weaker for the aromatic fluids than for the aliphatic fluids. The size distributions of diamond particles indicate that smaller diamond particles are produced by detonation of octogen with a heavier filler fluid, growth of diamond particles evidently also ceasing sooner under higher pressure and at temperature in the reaction zone. The author thanks V.M. Titov for attentiveness, V.N. Kolomiychuk for determining the size distributions of particles, and F.A. Sagdiyev for assisting in performance of the experiments. Figures 2; tables 1; references 10.

Problem of Determining Width of Compression Zone for Solid Material in Shock Wave

927J0126C Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 27 No 5, Sep-Oct 91 (manuscript received 27 Nov 90) pp 140-143

[Article by A. L. Bugrimov, Moscow; UDC 539.63]

[Abstract] Compression of a solid material in a shock wave is analyzed, of concern being the width of the compression zone. A plane shock wave with a sawtooth profile is considered and the dependence of the mass velocity $Q = V(1- \rho_0/\rho)$ (V- wave velocity, ρ_0- density of unperturbed material, ρ- density of material under compression) on the distance from the shock front or on the pressure P is determined, that distance varying in time from zero to L at the end of the compression zone. For the purpose of analysis in the one-dimensional approximation, a circular cylindrical segment of the solid medium is considered which has a unity cross-sectional area, its axis being oriented in the direction of shock wave propagation. Assuming that the dependence of the material density ρ on the pressure P follows the experimentally validated relation $P = A[(\rho/\rho_0)^m - 1]$ (A,m-constants), expressions are derived from it for the pressure dependence of the material density ρ and for the pressure dependence of the mass velocity $Q = (L_0 - L)\Delta t$ ($\Delta t = L_0/V$ characteristic time of wave propagation through distance L_0 in unperturbed zone). With the aid of the expression for the distance through which a solid particle has moved $h = \mathrm{Int}_0^L V^{-1}q(l)dl$ is then obtained an expression for the upper limit L representing the width of the compression zone. This expression is expediently simplified by expansion of the integrand into a Taylor series and subsequent truncation of the latter, but it can also be evaluated by an iterative method. Figures 3; references 5.

Shock Waves in Dissipative Polydisperse Bubbling Media

927J0109A Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA in Russian No 5, Sep-Oct 91 (manuscript received 22 Jan 90) pp 26-34

[Article by S. L. Gavrilyuk and S. A. Filko, Novosibirsk; UDC 532.529.5]

[Abstract] The structure of shock waves in an incompressible nonviscous fluid containing bubbles is analyzed, assuming a low concentration and a finite discrete size distribution of bubbles. The analysis is based on a system of four equations of motion in time t,q coordinates (t- time, q- Lagrangian mass) and two equations of state, one for each phase. Solutions to this system which are functions of the ξ= q- Dt coordinate only are sought (velocity of traveling wave $D > 0$), the system having been supplemented with an equation for the radii of bubbles. Following normalization of the variables, which transforms the equations into dimensionless ones, a transition is made to canonical variables and thus a

Hamiltonian system of equations shown, by means of a lemma, to be equivalent to the original one. Singular points in x,dx/dt coordinates are found and, with the aid of two lemmas, are established the conditions for stability of traveling waves. Linearization in the vicinity of singular points is undertaken with the aid of three lemmas, whereupon surfaces of the Hamiltonian level are examined. Two theorems about that system of equations are subsequently proved pertaining to uniqueness of a solution and existence of a trajectory respectively: 1) if a solution exists which joins two quiescent points $(q_0,0)$ and $(q^*,0)$, then this is the unique solution; 2) there exists a trajectory which joins two quiescent points $(q_0,0)$ and $(q^*,0)$. References 9.

Use of High-Resolution Electron Microscopy in Research on Structure of Tungsten Oxide Synthesized at Increased Pressures

927J0230B Moscow KRISTALLOGRAFIYA in Russian Vol 37 No 3, May-Jun 92 (manuscript received 18 Sep 91) pp 617-624

[Article by Yu. A. Barabanenkov, N. D. Zakharov, I. P. Zibrov, V. P. Filonenko and P. Werner, Crystallography Institute, Russian Academy of Sciences; High Pressures Physics Institute, Russian Academy of Sciences; Solid State Physics and Electron Microscopy Institute, Halle]

[Abstract] The phases reliably registered in the W-O system which are stable at normal pressure are reviewed. Then a high-resolution electron microscope and digital methods for the processing of electron microscope images are used in studying the phase composition of a sample of a W-WO_3 mixture synthesized at a high pressure and in determining the crystal structures of the phases present in it. The sintering of this mixture at pressures of about 60 kbar leads to the formation of at least two earlier unknown phases. A new tungsten oxide $WO_{1.09}$ in which W is present in a tetrahedral coordination was obtained, a structure which can be interpreted as some intermediate stage in W oxidation. A model of transformation of the structure of $WO_{1.09}$ from W is given. This structure has adequate stability at atmospheric pressure and does not break down when exposed to an electron beam. The results demonstrate the increasing possibilities of high-resolution electron microscopy in the field of structural analysis of crystals. Due to the very small size of the crystals and their relatively low volumetric content it is impossible to check the correctness in determining structure by means of X-ray structural methods. Figures 4; references: 11 Russian.

Optical and Structural Properties of Epitaxial AgI Films

927J0200C Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 4, Apr 92 (manuscript received 11 Jul 91) pp 611-615

[Article by R. Galbadrakh, V. K. Miloslavskiy, O. N. Yunakova and V. V. Karmazin, Kharkov University imeni A. M. Gorkiy. UDC 535.323+535.341: 537.311.33]

[Abstract] Traditional methods for preparing single-phase AgI films have a number of significant shortcomings. Accordingly, information is given on a new method for the growth of single-phase epitaxial β-AgI films by the vacuum deposition of AgI onto NaCl crystalline substrates heated to a preparation temperature T_p = 50-100°C. The orientation of specific crystallites favors a proximity of the interplanar distances $d_{10.0}$ = 3.97 A in β-AgI and d_{110} 3.99 A in NaCl. The absorption spectra and Faraday rotation of films in the region of long-wave excitonic bands were studied at the temperature of liquid nitrogen. The principal difference between the excitonic spectra of the films and the spectra of the β-AgI monocrystal is determined by the orientation of the crystallites on the NaCl substrate and the thermal strains caused by the difference between the thermal expansion coefficients of the film and substrate. Due to Poisson expansion of the films along the polar axis there is a nonlinear increase in the energy of the intracrystalline field with an increase in T_p and a transition to the cubic γ phase when $T_p > 100$°C. Figures 3; references 11: 4 Russian, 7 Western.

Vibron Effects in Surface Phases and in Molecular Electronics

927J0250A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 33 No 2, Mar-Apr 92 (manuscript received 9 Oct 92), pp 3-18

[Article by V. B. Zaytsev, A. V. Zoteyev, V. F. Kiselev, and G. S. Plotnikov, Department of General Physics and Molecular Electronics, Moscow State University; UDC 592.315.621]

[Abstract] Experimental data indicating a large role of vibron (electron-vibrational) effects in S-D-M_{ads} structures (S- semiconductor, D- dielectric, A- adsorbed molecules) are interpreted and correlated with theory, considering that excitons, polaritons, polarons, solitons, or other excited states can as well as only electrons, holes, phonons, photons alone effect signal transmission through an S-D-M_{ads} device. The role of vibron effects in charge carrier capture and recombination events is examined, of particular interest being these effects in surface phases of some crystals. The interrelation between these effects and excitations of the electronic system in a solid is particularly well demonstrated by both spatial and energy distributions of localized principal groups of surface electronic states in multilayer Si-SiO_2 and Ge-GeO_2 heterojunctions. The fast surface electronic states, some of them acting as recombination states, are shown to be localized under the semiconductor surface. The recombination rate is shown to depend on the surface potential as well as on the temperature, surface hydration shifting the maximum recombination from zero surface to a positive potential which is higher after hydration with D_2O than after hydration with H_2O at room temperature. Not only capture and recombination but also generation of charge carriers all depend strongly on the properties of the formed semiconductor-dielectric interface as well as on the characteristics of surface electronic states, the sites of slow states in that interface being dipole donor-acceptor complexes of adsorbed molecules with coordinate-unsaturated semiconductor (Si,Ge) atoms in the disordered nonstoichiometric (Si,Ge)O_x ($x < 2$) interlayer. The role of vibron effects in photochemical conversion processes on the surface is examined next, considering that the stored vibron energy in an excited adsorbate complex with a relatively long life of 10-100 μs can stimulate defect formation, photoadsorption, and desorption, also catalysis within the surface phase. From the

practical standpoint, of interest are vibron effects in S-D-M_{dye} structures (M_{dye}- organic dye molecules) and S-D-LBF structures (LBF denoting a Langmuir-Blodgett film). Two noteworthy promising applications for vibron effects in molecular electronics are selective sensors for composition analysis of gas-liquid mixtures and devices for simulation of various biological processes, particularly those which combine electronic and ionic (protonic) ones. Figures 9; references 39.

Local Thermal and Acoustic Processes During Braking of Fast Charged Particles in Crystals

927J0255A Minsk VESTNIK BELORUSSKOGO GOSUDARSTVENNOGO UNIVERSITETA IMENI V. I. LENINA. SERIYA 1. FIZIKA, MATEMATIKA, MEKHANIKA in Russian No 1, Jan-Apr 92 (manuscript received 4 Apr 91) pp 10-13

[Article by A. P. Novikov, A. I. Urbanovich, Nguyen Van Kong (Socialist Republic of Vietnam) and O. S. Khadarina; UDC 621.315.592:546.28]

[Abstract] With the transit of a charged particle through matter a defective track region is formed along its trajectory. The accompanying crystal structure defects are frequently attributed to the appearance of a sharp temperature increase. In order to clarify this matter computations of an acoustic signal from an overheated region were made for short time intervals following the moment of passage of a particle through a thin plate of matter of a stipulated thickness on the assumption that the track is a cylindrical region of a given radius in which there is a continuous release of energy of a constant intensity. Such a model is correct for focused ion beams and even for individual particles under the condition that the rate of transfer of the energy released in the track into the boundary region is constant. The acoustic signal arising near the track of a charged particle having finite transverse dimensions is analyzed. The solutions which are found take into account the finite rate of transfer of thermal energy in the medium. An expression is derived which makes it possible to determine the temperature around the track. References 7: 3 Russian, 4 Western.

Interference in Silicon-on-Sapphire Films During Light-Induced Reflection

927J0111A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 36 No 10, Oct 91 (manuscript received 18 Feb 91) pp 1479-1484

[Article by A. A. Galetskas and M. B. Petrauskas, Vilnius University; UDC 621.373.826.038]

[Abstract] An experimental study of thin silicon-on-sapphire films and light-induced change of their reflectivity was made concerning the linear relation between changes of their reflectivity and of their refractivity. Films were excited with 0.53 μm second-harmonic YAG:Nd^{3+}-laser radiation in pulses of 25 ps duration in the reflection strobing mode, the intensity of excitation not exceeding 20 mJ/cm^2 and thus remaining below the 100 mJ/cm^2 surface breakdown threshold. The reflection coefficient for 1.06 μm fundamental YAG:Nd^{3+}-laser radiation was measured during excitation of films and during relaxation of excess charge carriers in the plasma. These measurements were made with probing 1.06 μm radiation pulses of 30 ps duration optically lagging the excitation pulses by various lengths of time Δt. Most favorable for measuring light-induced reflection was a p-polarized beam of attenuated focused light incident at a 68° angle. The data are analyzed and interpreted by referral to electrophysical processes taking place in a semiconductor as it absorbs a light pulse which excites its electron-hole plasma, namely generation of free charge carriers during the pulse and relaxation of excess charge carriers after the pulse. The attendant changes of reflectivity and refractivity are then evaluated theoretically, by numerical simulation of dynamic interference of light according to the equations of multiple reflection for thin films and by treating a silicon- on-sapphire structure in air as an analog of a Fabry-Perot interferometer. Absorption of the 1.06 μm probing light is disregarded. Calculations are made on the basis of the Born-Wolf relation for the effective reflection coefficient, this relation being applied to a semiconductor film between air and an insulator substrate. The reflection coefficient at the air-silicon is calculated in accordance with according to the Bergner-Bruckner-Schroeder model (OPTICAL QUANTUM ELECTRONICS Vol 14, 1982). The relative change of the reflection coefficient due to refraction at the air-silicon boundary and the subsequent phase shift attending passage of some light through the silicon film and its return passage upon reflection at the silicon-sapphire boundary is calculated for the specific conditions of the experiment: thickness of silicon-on-sapphire film up to 10+/-0.25 μm, air-to-silicon refractive index 3.6, silicon-to-sapphire refractive index 1.76, reflection coefficient without excitation by 0.53 μm light $R_0 \approx 0.03$, probing 1.06 μm light incident at 68° angle, diameter of light beam $d \leq 100$ μm. These calculations, made for three thicknesses of the silicon-on-sapphire film (10.015 μm, 10.000 μm, 10.095 μm), cover the 0-50 mJ/cm^2 range of excitation energy (0.53 μm light) and the 0-800 ms range of probing pulse lag behind excitation pulse. They reveal an N-form dependence of the relative light-induced reflectivity change $\Delta R/R_0$ on the excitation intensity with successively lower peaks, $(gDR/R_0)_{max}$ theoretically increasing as the film thickness is increased but actually found to remain almost constant as the film thickness exceeded 3 μm. Its dependence on the time lag of the probing pulse behind the excitation pulse reveals an oscillatory character of the light-induced effect, with one reversal of sign after a prolonged mild initial stage, evidently attributable to its nonlinear dependence on the excitation intensity. Figures 5; references 14.

Propagation of a Heat Wave Along a Fractal Filament

927J0239C St. Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 12, Dec 91 (manuscript received 20 Nov 90; after revision 27 May 91) pp 82-87

[Article by B. M. Smirnov, Institute of High Temperatures, Moscow]

[Abstract] This article examines the condensation of the structure of aerogel and fractal filaments, which involves the contraction of the specific area of an internal surface. The mechanics of this process are presented and expressions for its speed are obtained. The propagation of a heat wave of structural condensation along a fractal filament is analyzed and estimates are obtained for its parameters. This process is significant in the physics of ball lightning. It is found that under certain conditions, a heat wave may propagate along a fractal filament creating a zone with a temperature close to 2000 K. This zone is a source of light. A tangle of fractal filaments forms the framework of ball lighting and a thermal structural condensation wave propagating along these filaments creates the luminescence of ball lightning. Fractal filaments and clusters are discussed and the condensation of aerogel structure is outlined. Figures 3; references 16: 10 Russian, 6 Western.

Nonisothermic Flow of a Nonlinear-Viscoplastic Fluid in a Radial Annular Slot

9270240A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 62 No 4, Apr 92 (manuscript received 18 Jun 91) pp 574-578

[Article by N. V. Tyabin, V. M. Yashchik, and V. O. Yablonskiy, Volgograd Polytechnical Institute; UDC 532,135L621,822,5]

[Abstract] The problem of a nonisothermic flow of nonlinear-viscoplastic lubricant in the radial annular slot of a thrust hydrostatic bearing is solved theoretically. The load-bearing capacity of the bearing is determined in relation to the rheological lubricant properties. Heat transfer between lubricant and the bearing walls bounding a flow is studied theoretically. The rotation of bearing surfaces is ignored because it is assumed that the bearing is rotating slowly. It is also assumed that convective heat transfer is negligible and the lubricant properties are independent of temperature and pressure. It is found that one should use a lubricant with the highest possible effective viscosity to reduce the flow rate of lubricant and increase the load capacity. Thus, the load capacity can be regulated through the flow rate of lubricant. Figures 2; table 1; references 6: 5 Russian, 1 Western.

Effect of Magnetic Field on Velocity Potential of Moving Aqueous Systems

927J0242B Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 62 No 3, Mar 92 (manuscript received 14 May 91) pp 391-395

[Article by I. M. Ametov and R. V. Mustafin, All-Union Scientific Research Institute of Petroleum and Natural Gas imeni Academician A. P. Krylov, Moscow; UDC 622.276.344]

[Abstract] An experimental study was made concerning the effect of a constant transverse magnetic field on the velocity potential of water moving through a capillary and the feasibility of regulating this effect by means of various additives. The apparatus included a 1.2 m long glass tube with a 5 mm inside diameter in a 1.4 m long shielding jacket of galvanized sheet metal 22 mm in diameter, silver wire electrodes 0.75 mm in diameter connected to lead wires at each of the glass tube (interelectrode space inside glass tube 0.84 mm long), a magnetizer, a V7-27A/1 general-purpose digital voltmeter with an operational amplifier recording the velocity potential, a piezometer tube connected to leads at each end of the glass tube, a metal container with fluid under constant pressure monitored by a manometer, a tank containing compressed nitrogen with two reducing air valves for coarse and fine pressure regulation, and a set of pipes with faucets. The interelectrode space inside the tube was 0.84 m long and the wetted electrode surface was flash with the inside tube surface. The magnetizer consisted of two permanent magnets inside a cast iron housing. The magnetic field intensity in the air gap was 176+/-17.6 kA/m and the total magnetic flux was 2.7-3.0 mWb. Tests were performed with tap water and with 0.15, 0.3, 0.5 vol. percent solutions of ML-72 additive (dark brown odorless medium-viscosity mixture of synthetic surfactants including biodegradable anions and nonionogenic substances soluble in sweet water, in sea water, and in water under petroleum layers). The velocity potential of nonmagnetized and magnetized water was measured as a function of the Reynolds number, which was varied from 0 to 140 in steps of 20. The length of time of fluid passage through the magnetic field depended on the fluid velocity, typically 150 s when the Reynolds number was 25. As the Reynolds number was increased from zero up without magnetization, the velocity potential of water alone and with surfactant was found to first dip to a minimum at a velocity within the N_{Re} = 20-25 range and then rise to saturation or a mild peak. The effect of magnetization was found to lower the velocity potential for water alone throughout the entire range of Reynolds numbers, to a minimum at a velocity within the N_{Re} 75-85 range, but not necessarily for water with surfactant. Its effect on water with surfactant ranged from lowering to raising the velocity potential, depending on the surfactant concentration and the Reynolds number. An analysis of the experimental data following their interpolation reveals a synergic cooperative lowering of the velocity potential by the magnetic field and the surfactant when the Reynolds number was small ($_{Re} < 8$) and the surfactant concentration is low (0.15 vol. percent). Figures 4; references 8.

Nonlinear Generation of Viscous Waves in Superfluid Helium

927J0159B Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 18 No 2, Feb 92 (manuscript received 13 May 91) pp 106-107

[Article by N.I. Pushkina, Moscow Sate University imeni M.V. Lomonosov, Moscow; UDC 532.132]

[Abstract] Nonlinear generation of transverse viscous waves by a second sound in superfluid He II is analyzed on the basis of equations of two-fluid superfluid hydrodynamics, which reduce to an equation for the nonlinear "force" N of second sound and viscous wave interaction. Inasmuch as this nonlinear "force" has nonzero nonviscous components much larger than the viscous ones, the latter are omitted from the right-hand side of that equation. Two second-sound shear waves $\delta T_{1,2}\exp(k_{1,2}r - \omega_{1,2}t)$ + c.c. (complex conjugate) propagating through superfluid He II at an arbitrary angle θ to each other under steady-state conditions are considered, the equation for the nonlinear "force" being solved for the transverse viscous shear wave which such a second sound generates. From the solution are derived expressions for the frequencies $\Omega_{+/-} = \omega_1 +/- \omega_2$, the attenuation, and the velocities $v_n^{\Omega(+),\Omega(-)}$ of this viscous shear wave. Numerical estimates based on approximate but sufficiently accurate expressions for the entropy and the normal density of He II at a $T \approx 1$ K temperature (at which phonons and rotons contribute about equally to

the entropy) indicate that second sound generates transverse viscous waves much more efficiently than does first sound. References 3.

Generation of Tsunamis by Oscillations of a Region of the Bottom

927J0233C Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 33 No 1, Jan-Feb 92 (manuscript received 4 Apr 91) pp 109-111

[Article by M. A. Nosov, Department of Physics of the Sea and Inland Waters, Moscow University; UDC 551.466]

[Abstract] Based on the linear potential theory, this article examines the problem of generating surface waves in a layer of homogeneous heavy liquid by steady-state harmonic oscillations of a portion of the bottom. It is found that not all oscillations of the bottom are capable of effectively generating surface waves. Oscillations of a bottom with linear dimensions smaller than the depth of the liquid layer will be relatively weakly manifested on the surface. The existence of a set of frequencies at which no waves are radiated from the generation region is associated with the specific spatial distribution of the amplitude of bottom oscillations. Moreover, one can define upper and lower limit frequencies. When these limits are exceeded the amplitude of the waves radiated form the generation region will be substantially smaller than the amplitude of the bottom oscillations. The spectrum of real tsunami waves lies within these limits, and this is supported by data in the literature. Figure 1; references 3: 2 Russian, 1 Western.

Kinetic Phenomena in a Solid Solution of $Bi_{2-x}In_xTe_{2.85}Se_{0.15}$

927J0238A St. Petersburg FIZIKA TVERDOGO TELA in Russian Vol 33 No 12, Dec 91 (manuscript received 2 Jul 91) pp 3539-3545

[Article by G. T. Alekseyeva, P. P. Konstantinov, V. A. Kutasov, L. N. Lukyanova, T. Ye. Svechnikova, and S. N. Chuzhevskaya, A. F. Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg; UDC 537.311.322]

[Abstract] In a solid n-type solution of $Bi_{2-x}In_xTe_{2.85}Se_{0.15}$ ($0 < x < 0.04$) and $Bi_{2-x}In_xTe_3$ ($x = 0.06$ and 0.12) an analysis is conducted of galvanomagnetic and thermoelectric properties according to the data on the temperature dependences of kinetic coefficients (components of tensors of specific resistance ρ_{11}, thermal EMF α and the Hall coefficient ρ_{ijk}) measured at 77-300 K. It is shown that the character of the change in the Hall coefficients ρ_{123} and ρ_{312}, depending on temperature, is associated with the different anisotropy of electron scattering in the cleavage plane (0001) and in the direction <111> which is perpendicular to the cleavage plane. This article also discusses the principles behind the sharp decrease in mobility of charge carriers μ_0 as the concentration of In atoms in the solid solution increases (a decrease in antistructural defects as Bi atoms are replaced by In atoms, the generation of local extrinsic states of In). A dependence is established between the mobility μ_0, the thermoelectric effectiveness Z and the anisotropy of the tensor of the relaxation time τ in the solid solution, according to which lower electron scattering anisotropy corresponds to a higher Z. Figures 4; table 1; references 15: 8 Russian, 7 Western.

Percolation and Diffusion in Fractal Turbulence

927J0167A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 61 No 4, Oct 91 (manuscript received 2 Oct 90) pp 540-545

[Article by A. G. Bershadskiy (deceased), Makeyev Institute of Engineering Physics; UDC 532.517.4]

[Abstract] Diffusion of a passive admixture into a turbulent fluid is considered, turbulence being treated as a fractal one and analyzed most effectively on the basis of a statistical model of critical percolation. The entire region of flow is accordingly subdivided into cubic cells with edge length η (Kolmogorov scale) so that the state of miscibility will prevail at any instant of time, with a turbulent flow within some cells and a laminar flow within others. The probability of turbulization is then defined so that $p = 0$ corresponds to no turbulization and $p = 1$ corresponds to complete turbulization of a cell, $p << 1$ corresponding to clusters of few turbulized cells only. On the premise that a particle of passive admixture in random motion within a fractal region occupied by turbulized fluid can hardly leave that region and enter a region of laminar flow, the mean square r^2 of the distance r traveled by such a particle within a fractal region in a time t is proportional to $t^{2/(2+\theta)}$ (θ- index characterizing anomalous diffusion) rather than proportional to t as in the case of Brownian movements in a homogeneous medium. The effective diffusion coefficient is $K^*(r)$ is then proportional to $r^{-\theta}$. The equation of admixture concentration kinetics $\delta c/\delta t = (1/r^{D-1})\delta K r^{D-1-\theta}/\delta r)(\delta c/\delta r)$ - (u del)c accordingly includes the diffusion coefficient K in the first term on the right-hand side (the second term representing convective transfer of admixture particles). While degeneracy of the admixture concentration is determined by internal random movements of free admixture particles, effects such as expansion of an admixture cluster are determined by their external random movements. The kind of random movements taking place is shown to depend on the topological boundary of the fractal region: their external random movements being determined by the dimensionality D- 1 of that boundary and $\theta = D - 3 < 0$ ($D < 3$) when the fractal dimensionality of their trajectories are larger than D- 1, lest particles "stray" at the boundary. The effective diffusion coefficient K^* is then proportional to r^{3-D}, or to $r^{1/2}$ in the case of three-dimensional turbulence with an unstable fractal dimensionality ($D_i \approx 5/2$) and proportional to $r^{4/3}$ ($D_s \approx 5/3$, Richardson's law) in the case of a stable dimensionality.

Oceanic studies are concerned mainly with two-dimensional turbulence, in which case K* is proportional to $r^{1.1}$ ($D_i \approx 1.9$) and proportional to $r^{4/3}$ ($D_s \approx 5/3$) respectively. These relations agree closely with experimental data. By taking into account the universal critical characteristics in the study of mass transfer processes, it should thus be possible to establish a consistent correlation between data obtained in small-scale laboratory experiments and in large-scale field experiments. Figures 1; references 9.

New Method of Solving Nonlinear Problems of Waves in Heavy Stratified Fluid Generated by Vertically Moving Solid Body

927J0150B Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 5, Sep-Oct 91 (manuscript received 26 Nov 90) pp 151-160

[Article by I. M. Mindlin, Nizhniy Novgorod; UDC 532.59:517.958]

[Abstract] An ideal incompressible fluid is considered which flows symmetrically about a vertical axis and consists of two fractions segregated into two horizontal layers, a heavier fraction occupying the lower layer and a lighter fraction occupying the upper layer. A solid body of revolution symmetric about the same vertical axis is considered which can move in the fluid but only vertically up and down. Conditions may arise under which a vortex sheet will cover the horizontal boundary between the two fluid fractions, owing to their density difference and the consequent step change of the tangential flow velocity component at that boundary. By virtue of the axial symmetry, only one vertical half-space needs to be considered. The problem is formulated in four systems of coordinates: 1) a Cartesian absolute system framing the fluid, its fixed vertical axis $O_1 x_1$ coinciding with the axis of symmetry and fixed horizontal axis $O_1 y_1$ lying on the interlayer boundary; 2) a Cartesian system framing the solid body with the origin O at its geometrical center, the vertical axis Ox coinciding with and moving along the $O_1 x_1$ axis (also axis of symmetry) and the horizontal axis Oy remaining parallel to the $O_1 y_1$ axis (the two horizontal axes coinciding when point O crosses the interlayer boundary in the fluid and thus coincides with the origin O_1; 3),4) two systems of curvilinear curvilinear coordinates (ρ,θ) and (σ,θ) in the meridional half-plane, disposed so that the boundary of the solid will be described by the equation $\rho = 1$ and the interlayer boundary in the fluid will be described by the equation $\sigma = 0$. The problem is defined by four partial differential equations of motion for the fluid involving the flow function in terms of the vector potential. The system of equations is closed by Newton's ordinary differential equation of motion for the solid body, diffusion of fluid through the interlayer boundary and surface tension being disregarded. An analytical solution to this system of equations for given initial conditions can be obtained in the form of power series, in integral powers of time t, such a form being required for a subsequent numerical solution of the problem. This method of solution is, therefore, proposed for solution of such nonlinear problems. It is demonstrated on the problem of a solid sphere which slowly buoys from far underneath the boundary between the two fractions of an initially quiescent fluid and in the process generates oscillations of that boundary in the form of surface waves. Figures 2; references 16.

Finite Propagation Velocity and Localization of Perturbations During Nonlinear Relaxational Filtration

927J0109B Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA in Russian No 5, Sep-Oct 91 (manuscript received 24 Jan 90, final version received 3 May 90) pp 102-106

[Article by U .G. Abdullayev, Baku; UDC 536.24:517.9]

[Abstract] Nonsteady filtration through a porous medium is analyzed on the basis of the equation $v + \lambda_v \delta v/\delta t = k\delta(p + \gamma_p \delta p/\delta t)/\mu\delta x$, which represents the linear approximation of the extended Darcy's classical law and which, according to the theory of elastic flow, leads to the nonlinear equation of relaxational filtration $\delta p/\delta t + \lambda_v \delta^2/\delta t^2 = \kappa\delta^2[p + \lambda(\delta p/\delta t)^2]/\delta x^2$ (v-velocity, p= pressure, $k > 0$ permeability of porous medium, μ- kinematic viscosity of fluid, $\lambda_v > 0$ velocity lag time, λ_p- pressure relaxation time, κ-numerical coefficient dependent on properties of the porous medium). The pressure relaxation time λ_p is assumed to be proportional to the rate of change of pressure $\delta p\delta t$, λ being the proportionality factor. Pressure perturbations of such a filtration process propagating at a finite velocity u are considered, their velocity being finite only when λ= var is a continuous function of (u in R^1- space). Two interesting examples are $\lambda(u) = |u|^n$ ($n > 0$) and $\kappa\lambda(u) = \lambda_\varepsilon(u)$ where $\lambda_\varepsilon = \varepsilon^2/(1+\varepsilon u) - \varepsilon \log(1+\varepsilon u)/u(1+\varepsilon u) - \varepsilon^3 u/2(1+\varepsilon u)^2)$ ($u > 0$, $\lambda_\varepsilon(0) = 0$, $\varepsilon > 0$ arbitrary positive number). In the latter case $\lim_{\varepsilon \to 0} \lambda_\varepsilon(u) = 0$ for any $u \geq 0$ and, owing to the dependence of λ on $\delta p/\delta t$, the boundary conditions will become localized with preemphasis even though λ can be made arbitrarily small by proper choice of the ε number. The author thanks A.Kh. Mirzadzhanzade for posing the problem and discussing the results. Figures 3; references 7.

Simultaneous Two-Wave Far-Infrared Laser Emission for Interferometry With Visualization of Interference Pattern

927J0227B Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 30 No 3, May-Jun 92 (manuscript received 25 Jul 91) pp 592-600

[Article by A. A. Lash, D. N. Yundev, and V. M. Grine, Scientific Experimental Institute of High Temperatures at Russian Academy of Sciences; UDC 621.375.826]

[Abstract] Use of an infrared laser which emits radiation at two different wavelengths within the far-infrared region of the spectrum and simultaneous recording of both emissions are proposed for a two-wave interferometer. The advantage of a two-wave interferometer over a single-wave one are that it either covers a wider range of a measured parameter (e.g., electron concentration in a plasma) or can measure more parameters (e.g. concentrations of all neutral particles in a multicomponent plasma). It is also easier to analyze two-wave interference patterns recorded by a probing beam which has been attenuated and refracted in the object of measurements. The advantages of simultaneous over sequential recording are its usefulness in interferometry of short-lived objects and insensitivity of the measured phase shift to vibrations. The only four optically pumped gas-discharge $\lambda < 300$ μm lasers sufficiently powerful for plasma probing are the HCN (DCN) and H_2O (D_2) vapor lasers, but they emit only at fixed frequencies so that two lasers are needed and merging their beams is necessary for two-wave interferometry. Most promising for such an interferometry have been found to be the CH_3OH vapor laser and the CD_3OD vapor laser: the former emits 111.8 μm and 170.6 μm radiation when pumped with 9P36-line radiation of a CO_2-laser (its 392 μm radiation is very weak), the latter emits 184.8 μm and 298.7 μm radiation when pumped with 10R24-line radiation of a CO_2-laser. The two wavelengths are in each case sufficiently far apart for the intended purpose, unlike the two emission wavelengths of other organic lasers (HCOOH, CH_3F), and the two waves are in each case polarized in quadrature. The evident advantage of pumping with a CO_2-laser is its tunability over the 9-11 μm range. Considering the difficulty of theoretical analysis, simultaneous two-wave emission of both lasers was studied experimentally. The apparatus included an Edinburgh Instruments PL-4 infrared CO_2-laser pump, a far-infrared cell with a 1500 mm long resonator and a 36 mm wide circular waveguide made of pyrex, and two plane mirrors with two holes: one 2 mm wide for injection of pumping radiation and one 10 mm wide for extraction of far- infrared radiation. Both mirrors were gold-coated for reflection of infrared light. The purpose of the experiment was to determine the operational pressure range for the two organic-vapor lasers and the optimum pressure for emission at each wavelength, also to experimentally evaluate the dependence of the two-wave laser emission power in both continuous-wave and pulsed modes on the pump power. The two wavelengths of laser emission were separated by means of a one-dimensional wire grid, suitable for waves polarized in quadrature. Power of the pumping CO_2-laser was measured with a Lasercraft P-1 wattmeter. The whole optical system was aligned relative to an He-Ne laser beam which, after its reflection by a plane mirror, a polyester fiber grid split into two beams accompanying each one of the two far-infrared wave beams. A prototype two-wave interferometer with visualization of the interference pattern was constructed with two one-dimensional wire grids, the first one (S_1) splitting the laser beam into a reference beam and an object beam. The latter beam was reflected twice, by two concave spherical mirrors $M_{1,2}$ with a 500 mm radius each, then split into the two differently polarized wave beams by rotation of the second grid (S_2) with a 40 μm period in the plane perpendicular to that incident (object) beam. Both these beams, the reflected one and the transmitted one, were each separately by a concave spherical mirror $M_{3,4}$ with a 380 mm radius and then a plane mirror $M_{5,6}$ sent to the target of a vidicon with a germanium window. The reference beam was split by a third wire grid (S_3) into two: one being reflected directly onto that vidicon target, one being transmitted and then reflected by another plane mirror (M_7) onto that target. This interferometer with a CH_{OH}-laser was tested on a 0.16 mm thick and 4.5 mm wide wedge made of templene (?). A parasitic interference pattern formed between the two useful ones and narrowed their, this being attributable to an inadequate beam splitting by the second grid (S_2) with a 40 μm period. Optimization of its period minimized the parasitic interference and, consequently better utilization of the recording surface of the vidicon target, increased the depth of field of the interferometer. The authors thank A.L. Golger for helpful discussions. Figures 8; references 21.

Bimodal Waveguide CO_2 Laser

927J0229A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 5, May 92 (manuscript received 22 Nov 91) pp 494-495

[Article by A. M. Golovchenko, S. T. Kornilov, V. Yu. Kurochkin, V. N. Petrovskiy, Ye. D. Protsenko and S. N. Chirikov, Moscow Physical Engineering Institute; UDC 621.373.826]

[Abstract] This is the first report on the results of experimental research on the interaction of two plane and orthogonally polarized modes in a waveguide CO_2 laser (working pressure up to 16 kPa, cavity length about 0.5 m). A study was made of the dependence of bimodal lasing on intermode distance for different pressures of the active medium and excesses of amplification over losses. Stable bimodal lasing is observed with a change in intermode distance from 0.3 to 140 MHz; its maximum region is about 180 MHz. The maximum output power in a bimodal regime is about 1 W. The experiments were conducted in a setup consisting of the investigated waveguide CO_2 bimodal laser with a phase-anisotropic cavity, single-mode laser oscillator, by means of which

the spectral composition of the radiation is controlled, and a recorder. The bimodal laser is based on a waveguide of rectangular section (1.5 x 1.0 mm) 300 mm in length fabricated from BeO plates and filled with a mixture CO_2:N_2He:Xe = 4:2:12:1 at working pressures 6.5-16 kPa. A d-c discharge is used in the waveguide. The laser cavity is formed by a plane mirror positioned in the immediatejneighborhood of the waveguide input and a spherical mirror with a curvature radius R = 0.2 m. The changeover to a waveguide cavity design considerably broadened the range of change in intermode distances in which stable bimodal lasing is attained. A further improvement in the cavity design will make it possible to reduce laser dimensions and increase power and the range of change of intermode distances. Figures 2; references 3: 2 Russian, 1 Western.

Semiconductor Laser With Solar Pumping

927J0229B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 5, May 92 (manuscript received 1 Nov 91) pp 505-508

[Article by I. M. Tsidulko, Physical Technical Institute imeni S. U. Umarov, Tajik Academy of Science; UDC 621.373.826.038.825.4]

[Abstract] An analysis is given of the possibility of effective transformation of incoherent radiation into laser radiation by means of semiconductor lasers with optical pumping. The presented materials show that efficient lasing can be achieved with a substantially lesser optical pumping power density than in other solar lasers by the incorporation of a variband absorbing layer designed in the form of a cylindrical sector whose broad and broad-band part is turned in the direction of the pumping radiation, whereas the narrow and narrow-band part adjoins the active layer. A design of such a laser is proposed in which the variband absorbing layer of p-$Al_yGa_{1-y}As$ has a total layer thickness not greater than 30 μm and the active layer of gallium arsenide is less than 10 nm thick; the width of the light-receiving surface does not exceed 60 μm and that of the active layer 1 μm. In the variband layer the radiation absorption spectrum is very close to the solar radiation spectrum, taking in virtually all of its visible part. Computations show that the lasing threshold will be attained with a density of solar radiation power about 4 W/cm^2 and the semiconductor laser efficiency may attain 40 percent, meaning that it is definitely superior to solar lasers proposed earlier. Figures 6; references 13: 2 Russian, 11 Western.

Control of Spectrum of Laser-Induced Surface Relief of GaAs in Photochemical Etching Process

927JO206C Moscow IZVESTIYA AKADEMII NAUK RAN: SERIYA FIZICHESKAYA in Russian Vol 56 No 4, Apr 92 pp 91-99

[Article by V. Ya. Panchenko, V. K. Popov, V. N. Seminogov and A. I. Khudobenko, Moscow State University imeni M. V. Lomonosov; UDC 535.621.373.8]

[Abstract] An experimental and theoretical study was made of the formation of periodic relief on an n-GaAs surface arising during photochemical liquid-phase etching under the impact of radiation from a CW Ar^+ laser. For the first time measurements were made of increments of the exponential increase in amplitudes of dominant structures directly in the course of their generation. The influence of the properties of different etching agents on the spectrum of the generated relief was investigated. Phased diffraction gratings with stipulated periods in the range 0.35-0.5 μm were obtained. The physical mechanism of this phenomenon was established by comparing the experimental and theoretical results. This comparison confirmed the findings in an earlier study (V. Ya. Panchenko, et al., KVANTOVAYA ELEKTRON., Vol 16, p 1226, 1989). The formation of the periodic relief occurs due to the spatially inhomogeneous generation of electron-hole pairs caused by the diffraction of incident radiation on the developing relief. The findings make possible purposeful formation of the surface relief spectrum and improvement in the quality of gratings by careful choice of the optimum combination of etching agent, intensity and angle of incidence of laser radiation. The results give a basis for the hope that the proposed single-step, mask-free method for fabricating diffraction gratings may find practical applications in optics. Figures 8; references 11: 9 Russian, 2 Western.

Effect of Forbidden Transitions on XeCl Molecule Gain Band Structure

927J0272C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 4 (238), Apr 92 pp 369-371

[Article by V. T. Platonenko, M. K. Shayakhmetova, Moscow State University imeni M. V. Lomonosov; UDC 621.373.826.038.823]

[Abstract] The effect of the forbidden transitions on the structure and shape of the XeCl molecule's *B-X* gain band is investigated in order to develop correct models used in describing the gain of pico- and nanosecond light pulses in an excimer laser. The spectroscopic constants of the XeCl molecules and the Frank-Condon factors of the XeCl molecules are summarized and the gain bands computed with and without taking the forbidden transitions into account, whereby the bound-bound transitions make the main contribution to the gain band, are plotted. For illustration, an experimentally plotted gain band formed by all transitions is examined. An analysis demonstrates that the band calculated by using the forbidden transitions is more consistent with the experimental measurements of the XeCl laser's stimulated emission wavelengths than the band plotted only by taking into account the allowed transitions. The forbidden transitions do not change the curve shape but shift it by some 4-5 cm^{-1} toward higher frequencies, thus confirming the premise that the forbidden transitions should be taken into account in analyzing the gain band and examining its kinetics. Figures 2; tables 2; references 9: 6 Russian, 3 Western.

Relativistic-Strictional Self-Channelling of Strong Ultrashort Laser Pulses in Matter

927JO204B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 4, Apr 92 (manuscript received 28 Jun 91) pp 1132-1153

[Article by A. B. Borisov, A. V. Borovskiy, V. V. Korobkin, A. M. Prokhorov, C. K. Rhoades and O. B. Shiryayev, General Physics Institute, Russian Academy of Sciences]

[Abstract] The self-channelling of a powerful ultrashort pulse in plasma caused by a change in the refractive index as a result of a relativistic increase in weight of the mass of electrons and their expulsion by a strictional force from the region of a powerful field is examined. The process is described by the nonlinear Shrodinger equation. An asymptotic tendency of an arbitrary two-dimensional axially symmetric solution of the nonlinear Shrodinger equation to the lowest spatially localized mode was established. It was found that the critical power of self-channelling coincides with the minimum power concentrated in the mode and is equal to $P_{cr} = 2P_{cr,c}$, that is, to the doubled critical power for a medium with quadratic nonlinearity. The practical application of self-channelling of the laser pulse will make it possible to obtain extended narrow regions with multiply charged ions in a very intense electromagnetic field with a strength about 10^{19}-10^{20} W/cm^2 in the absence of free electrons. The phenomenon affords possibilities for studying matter in very intense electromagnetic fields and also is of interest in the designing of an X-ray laser. Figures 5; references 42: 19 Russian, 23 Western.

Temperature Measurement of Silicon Plate in Plasmochemical Reactor By Laser Interferometry Method

927J0197A Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 30 No 2, Mar-Apr 92 (manuscript received 24 Oct 90) pp 372-378

[Article by A. N. Magunov and Ye. V. Mudrov, Microelectronics Institute, Russian Academy of Sciences, Yaroslavl. UDC 533.924+535.417+536.5+621.315.592]

[Abstract] The dependence of the refractive index of monocrystalline silicon on temperature in the range 20-350° was experimentally determined. The interferometry method was used in the registry of the kinetics of heating and cooling of a silicon plate in the oxygen plasma of a HF discharge. Measurements are made in a cylindrical quartz reactor (diameter 20 cm, length 40 cm, wall thickness 5 mm). The plate is positioned in a quartz holder perpendicular to the chamber axis. A capacitance discharge is excited by external electrodes positioned parallel to the cylinder axis at a frequency of 13.56 MHz. The oxygen pressure in the chamber is 50 Pa and the discharge power can be regulated in the range 100-400 W. A laser beam with a diameter 2 mm is incident on the plate through a quartz window of the chamber at an angle 5 degrees to the normal, is reflected and passes from the chamber through the same window and is detected by a germanium photodiode in a photogalvanic mode. The electric signal is registered using an automatic potentiometer. The temperature sensitivity of the method may attain 200 percent K^{-1} x mm^{-1}; the threshold response (the temperature change which can be detected) is about 0.01 °C. Figures 7; references 9: 4 Russian, 5 Western.

Nonlinear Self-Consistent Theory of Free-Electron Lasers: Case of Monochromatic and Transversely Uniform Excitation

927J0111B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 36 No 10, Oct 91 (manuscript received 6 Mar 91) pp 1485-1492

[Article by V. V. Kulish and A. V. Lysenko, Sumy Institute of Physics and Technology; UDC 537.86+621.373]

[Abstract] The earlier formulated general approach to a nonlinear self-consistent theory of free-electron lasers (V.V. Kulish; UKRAINSKIY FIZICHESKIY ZHURNAL Vol 36 No 9, Sep 91) is applied to a relativistic electron beam whose space-charge wave interacts with monochromatic transverse signal and pump waves, the electron beam being uniform and transversely boundless owing to absence of an external focusing magnetic field but being bounded longitudinally by the finite length of the interaction space. An asymptotic solution of the fundamental system of equations for this model in the case of fundamental parametric resonance leads to a truncated and averaged equation of kinetics in Bogolyubov's approximations, all nonlinearities of higher than third orders being disregarded. From that equation in Bogolyubov's first approximation is obtained a system of correspondingly truncated equations of kinetics for complex amplitudes of the beam-electrons distribution function. The distribution function is formally biperiodic, but its biperiodicity may be ignored under the constraint of approximate equality of phases as well as of their rates of change is required. This distribution function is expanded into a Fourier series, for a rough comparative quantitative analysis of the terms in the original equation of kinetics. The analysis reveals a significant difference between the kinetics in weak and strong space-charge fields. While retention of only the first two Fourier components will adequately account for cubic nonlinearities the case of a weak space-charge field, adequate accounting for cubic nonlinearities in the case of a strong space-charge field will require inclusion of second and third harmonics as well. A self-consistent system of four coupled equations is then obtained for the rates of change of complex amplitudes $f_{0,1,2,3}$ of the distribution function components. This system of equations is solved by the method of successive approximations, assuming that the relativistic electron beam is not modulated as it enters the interaction space. Expansion of the distribution function into a Taylor series leads to a system of truncated equations for complex amplitudes of the interacting waves, from which are then obtained expressions for both current

density and space charge of the relativistic electron beam. The authors thank S.S. Moiseyev for interest and helpful discussions. References 7.

Generation of Stimulated Radiation by a Running Ionization Front During Breakdown in Intersecting Beams of Radio Waves

927J0180 Moscow FIZIKA PLAZMY in Russian Vol 17 No 9, Sep 91 (manuscript received 17 Oct 90) pp 1131-1137

[Article by N. D. Borisov and A. V. Gurevich, Institute of Earth Magnetism, the Ionosphere, and Propagation of Radio Waves, USSR Academy of Sciences; UDC 537.56]

[Abstract] This article examines the idea of creating an artificial ionized region in the atmosphere during high-frequency pulsed breakdown in intersecting beams of radio waves. The appearance of a large number of fast electrons during breakdown should lead to the excitation of various electron states of molecules with subsequent generation of radiation. In the laboratory, ultraviolet radiation in the second positive nitrogen system was generated in a UHF discharge. A feature of the generation of radiation in free space is the presence of a running ionization front and the associated excitation of electron states. The intensity of stimulated ultraviolet radiation is expected to be 50-100 kW/cm^2. As altitude increases, intensity decreases sharply due to the drop in air pressure. Figure 1; references 9: 7 Russian 2 Western.

Effect of Right-Hand Current Addition and Neutrino Mass on Spin-Momentum Correlations in Nuclear β-Decay

927J0217A Moscow IZVESTIYA ROSSIYSKOY AKADEMII NAUK: SERIYA FIZICHESKAYA in Russian Vol 56 No 5, May 92 pp 168-174

[Article by B. K. Kerimov, M. Taysir, V. N. Alizade, Moscow State University imeni M. V. Lomonosov; UDC 539.165.2]

[Abstract] The importance of precision spin-momentum correlations in nuclear β-decay for investigating the structure of the weakly charged lepton current and neutrino properties and the methods of measuring the contribution of right-hand currents are discussed and an attempt is made to derive analytical expressions for the probability of allowed β transitions in both polarized and nonpolarized nuclei; in so doing, the lepton helicity, the neutrino nonzero mass, and the right-hand lepton current additions are taken into account. Fermi and Gamov-Teller transitions and mixed β-transitions are considered and the effect of the neutrino mass *m* and right-hand current addition on the degree of longitudinal polarization (SPP) of the decay's electrons and positrons and on the nuclear spin correlation with the antineutrino (electron) momentum for Gamov-Teller transitions is analyzed. The dependence of the degree of longitudinal electron or positron polarization on the lepton emission asymmetry coefficient is established on the basis of the four-Fermion local interaction Hamiltonian; the deviation of the longitudinal polarization degree from the predicted values is examined. It is shown that the ratio of the degrees of longitudinal polarization of positrons in the Fermi and Gamov-Teller transitions differs from unity the most (1.006) near the end points of the positron spectrum. Figures 3; references 9: 4 Russian, 5 Western.

Symmetric and Asymmetric Fission of ^{238}U and Np-237 Nuclei Tagged With 60-240 MeV Photons

927J0226A Moscow YADERNAYA FIZIKA in Russian Vol 55 No 4, Apr 92 (manuscript received 23 Sep 91) pp 907-919

[Article by D. I. Ivanov, V. G. Nedorezov, and A. S. Sudov, Institute of Nuclear Research at Russian Academy of Sciences; G. Ya. Kezerashvili, Mishnev, and G. M. Tumaykin, Institute of Nuclear Physics at Siberian Department, Russian Academy of Sciences, Novosibirsk; A. A. Turinge, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] Photofission of heavy nuclei tagged with medium-energy (60-240 MeV) photons and characteristics of the photofission products were studied with the ROKK-2 apparatus at the Institute of Nuclear Physics (Russian Academy of Sciences, Novosibirsk), this apparatus including a VEPP-3 electron accelerator-storage with four lenses between two arcuate magnets, a tagging system behind the second magnet, and an FD detector. The electron storage operated at a repetition rate of either 4 MHz or 8 MHz, the electron energy covering the 0.35-2.0 GeV range. The maximum photon energy was either 140 MeV or 220 MeV, the maximum intensity of the photon beam was $2x10^6$ photons/s, the tagging range was 30-270 MeV, and the energy resolution was 1-2 percent. The photon beam was calibrated by means of a laser optical system. The photon beam was monitored by two television cameras and the laser beam was monitored by one television camera. The targets were ^{238}U and Np-237 films 5 cm in diameter and 0.5 mg/cm^2 thick (for maximum possible reaction yield but also sufficiently high energy resolution) on 5 μm thick aluminum substrates. Twelve targets were placed one behind another but far apart in the interaction space between a "veto" anticoincidence plate for the incident photon beam in front of the first target. Twelve low-pressure chambers with a 72x80 mm^2 sensitive surface area each were placed one behind each target, their two cathodes 10 mm apart and anode 42 mm behind the respective target. Another scintillation counter behind the last proportional chamber was followed by an analogous but "empty" proportional chamber in the detector channel, isolated from fission fragments but connected into the data processing system. This proportional chamber was followed by another scintillation counter plate in front of a wide-aperture NaI:Tl detector filled with isobutane under a pressure of 0.1 atm. Tests were performed for a determination of both symmetric and asymmetric fission components. The symmetric component was evaluated on the assumption that large signals from the proportional chambers would correspond to light fission fragments, in accordance with the laws of energy and momentum conservation, assuming also Gaussian amplitude distributions of signals corresponding to fragments of symmetric fission as well as of those corresponding to heavy and light fragments of asymmetric fission. Processing of the data was done by the method of least squares and curve fitting, using two gaussoids in the first approximation and three gaussoids in the second approximation. An additional procedure was used for minimizing systematic errors due to pickup and noise. For an interpretation of the data, the results of their statistical analysis were used as reference in reliability testing of various hypothetical photofission models. According to the best estimates, the ratio of symmetric to asymmetric fission components is 46+/-4 percent for ^{238}U nuclei and 38+/-3 percent for Np-237 nuclei not appreciably dependent on the photon energy. The authors thank A.S. Ilyinov and M.V. Mebel for helpful discussions. Figures 9; tables 4; references 15.

Emission of Charged Particles With Up to 30 MeV/Nucleon Energy During Interaction of Muon Neutrino and Heavy Nuclei in Photographic Emulsion

927J0226B Moscow YADERNAYA FIZIKA in Russian Vol 55 No 4, Apr 92 (manuscript received 1 Jul 91) pp 1000-1009

[Article by P. A. Gorichev, O. K. Yegorov, E. D. Kolganova, Ye. A. Pozharova, N. V. Rabin, V. A. Smirnitskiy,

and V. V. Shamanov, Institute of Theoretical and Experimental Physics, Moscow; V. V. Ammosov, V. I. Baranov, V. A. Gapiyenko, V. I. Koreshev, P. V. Pitukhin, and V. I. Sirotenko, Institute of High-Energy Physics, Serpukhov; Yu. A. Batusov, S. A. Bunyatov, O. M. Kuznetsov, and V. V. Lyukov, Joint Institute of Nuclear Research, Dubna; B. Wilczycka, H. Wilczynski, B. Wojcek, V. Wolter, A. Olszewski, and A. Jurak, Institute of Nuclear Physics, Krakow (Poland); Kh. Chernev, Institute of Nuclear Engineering and Nuclear Physics, Sofia (Bulgaria); M. Ivanova, University of Plovdiv, Plovdiv (Bulgaria)]

[Abstract] An experimental study was made concerning emission of slow charged particles during ν-A interactions (ν- neutrino, A= Ag,Br nucleus) in photographic emulsion, its purpose being to test the evaporation theory of this process. The experiment was performed with neutrino "stars" which had been recorded in an experiment with neutrino-aided production of charmed particles. Cryosensitive photographic Ag and Br emulsions were placed inside a 15 ft long FNAL bubble chamber and bombarded with a beam of muon neutrinos, its energy covering the 10-200 GeV range with a mean energy of about 50 GeV according to detected events. The bubble chamber served also as a secondary-particles spectrometer. A total of 194 interactions involving neutrinos and antineutrinos were detected in a current of charged particles, the residual path lengths of the latter and their exit angles relative to the neutrino beam having been measured in the course of 109 events. The distributions of slow black b-particles (residual path length within 5-3600 μm range, kinetic energy of proton within 0.5-30 MeV range), relativistic s-particles, gray g-particles, and strongly ionized h-particles (h= b+g) in these events were determined for the purpose of analysis and interpretation. The data are analyzed on the basis of evaporation theory, according to which the proton energy per nucleon (regarded here as measure of the energy of slow particles) is $T(p)= T(x)/M(x)^{n-1}Z(x)^{2n}$ (n= 0.58), where T(x) denotes the energy of an isodromic x-particle with a mass M(x), a charge Z(x), and a path length R(x) (n= 0.58). The results of calculations made according to this theory are correlated with the results of calculations made by the Monte Carlo method, assuming that the main source of slow particles is a stochastic evaporation mechanism and that the probability of particle emission as a function of the particle energy corresponds to a Maxwell distribution not only for charged particles but also for neutral ones (particles (n,p,d,t,$^3He_2$, $^4He_2$). The height of the Coulomb barrier V(x) during surface emission of particles from a nucleus with an excitation energy E* is calculated according to the $V(x)= V(0x)\exp(-E^*/E_c)$ relation, where E_c= 640 MeV and V(0x) denotes the height of the Coulomb barrier when permeability and diffuseness of the boundaries of both nucleus and emitted x-particle are accounted for. The results of this analysis indicate that the evaporation model does adequately describe the emission of charged particles, if to evaporation of such particles from the equilibrium state of a moving target nucleus is added the action of a strongly excited heat source. The fast protons with energy higher than 15 MeV, about 35 percent of all protons, could have been produced by a local preequilibrium source, by an intranuclear cascade, or by any other process. Figures 7; tables 4; references 17.

Measurement of Dependence of Rate of Formation of Muon Molecules of Deuterium on Temperature for Different Spin States of dμ Atoms With High Deuterium Density

927JO204A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 4, Apr 92 (manuscript received 9 Jul 91) pp 1105-1117

[Article by V. P. Dzhelepov, V. G. Zinov, S. A. Ivanovskiy, S. B. Karpov, A. D. Konin, A. I. Malyshev, L. Martsish, D. G. Merkulov, A. I. Rudenko, V. V. Filchenkov and O. A. Yurin, Joint Nuclear Research Institute]

[Abstract] In experiments with high-density deuterium measurements were made of the temperature dependence of the rate of formation of ddμ molecules from two states of the superfine structure of the dμ atom, as well as the rate of transition between these states. After formulating the problem, the kinetics of the process of muon catalysis in deuterium is discussed and the experimental method and the processing of events are described. A comparison of the observations with the results of measurements of the OAW-PSI group, carried out with a low deuterium density, indicates the possible existence of a density effect in the formation of ddμ molecules from the state of a dμ atom with a spin F = 3/2. This interpretation is consistent with the theoretically predicted resonance formation of muon molecules, taking into account, in addition to the Wessmann mechanism, an impact broadening of the resonance. The measurement of the thermalization rate for dμ atoms in dense deuterium is discussed. Figures 8; references 36: 13 Russian, 23 Western.

Nonlinear Dynamics of CO_2 Laser With Periodic Modulation of Losses

927JO204C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 4 Apr 92 (manuscript received 26 Sep 91) pp 1177-1196

[Article by A. M. Samson, S. I. Turovets, V. N. Chizhevskiy and V. V. Churakov, Physics Institute, Belarus Academy of Sciences]

[Abstract] The results of experimental research on the nonlinear dynamics of a continuous-wave CO_2 laser with an optoacoustic loss modulator are given. The resonance structure of the nonlinear response was studied with different choices of modulation frequency relative to the frequency of relaxation oscillations. The correlation dimension and entropy for single- and multimode lasing

regimes were computed using the transverse index on the basis of experimental data. A study was made of laser dynamics near a bifurcation with a doubled period with additional δ-pulse resonator quality modulation by means of optically controllable absorption in the semiconductor elements of the laser. The presence of amplification of a weak signal near frequencies multiple of half the modulation frequency is demonstrated. The operation of a CO_2 laser with periodic modulation of losses of both binary and quadratic phase and amplitude optical triggers is described. In lasers with such modulation of the parameters for the first time a number of new effects were found having great practical possibilities, particularly in intracavity kinetic measurements and in optical data processing systems. Figures 8; references 65: 24 Russian, 41 Western.

Mesoscopic Fluctuations of Josephson Current in Small Junctions

927JO204E Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 4, Apr 92 (manuscript received 14 Oct 91) pp 1275-1281

[Article by V. V. Dorin and M. V. Fistul, Moscow Steel and Alloys Institute]

[Abstract] In an earlier study (M. V. Fistul, ZhETF, Vol 96, p 369, 1989) it was demonstrated that in unordered Josephson junctions the critical current may vary greatly from sample to sample and that random "mesoscopic" oscillations should be observed on the curve for the dependence of the critical current on the magnetic field. Such junctions include Josephson junctions in which there are great fluctuations of the superconducting order parameter. Continuing this research, the dependence of the critical current on the magnetic field is computed for the first time for a Josephson junction with allowance for fluctuations of the order parameter in one of the superconducting borders. It was found that the flowing of a Josephson current is possible above the temperature of transition into a superconducting state T_s. A sharp decrease in the critical current begins in the region of strong magnetic fields ($\Phi >> \Phi_0$), but random "mesoscopic" oscillations should be observed in the dependence $I_s(H)$. At a temperature $T < T_s$ phase fluctuations of the order parameter result in a decrease in the critical current and a distortion of the "Fraunhofer" dependence. Figures 2; references 11: 8 Russian, 3 Western.

Soliton Dynamics of Local Transitions in Bistable One-Dimensional System

927J0200A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 4, Apr 92 (manuscript received 23 Sep 91) pp 498-504

[Article by S. N. Volkov and A. V. Savin, Theoretical Physics Institute, Ukrainian Academy of Sciences; Physical-Technical Problems Institute, USSR Academy of Sciences. UDC 539.2;539.199]

[Abstract] Although the nonlinear dynamics of bistable chains with nonequivalent states was investigated earlier within the limits of single-component models, this made possible a description only of the processes of relaxation of excitation from a metastable state. It is now evident that qualitatively new results can be obtained when allowance is made for the mobility of an external sublattice. For linear macromolecular chains the introduction of the mobility of an external component naturally improves description of the dynamics of their structural transitions. Further development of this direction is most promising for the physics of macromolecules and molecular chains. This article describes soliton excitations of a bistable two-component chain with nonequivalent stable states. Soliton solutions of the equations of motion are found in the form of local structural excitations of the stable and metastable states. All the soliton solutions are obtained in a continuous approximation for the fundamental (stable) and metastable states of the system. The spectrum of velocities of solitons is found and their configuration and dependence on the parameters of the model are determined. Figures 3; references 17: 10 Russian, 7 Western.

Nuclear Magnetization Solitons in Magnetically Ordered Ultralow-Temperature Phase]

927J0212B St Peterburg FIZIKA TVERDOGO TELA in Russian Vol 34 No 1, Jan 92 (manuscript received 3 Jul 91) pp 124-128

[Article by L. L. Buishvili, N. P. Giorgadze, and N. G. Mchedlishvili, Tbilisi State University imeni Iv. Dzhavakhishvili; UDC 539.143.43]

[Abstract] Weakly nonlinear modulated magnetization perturbations in the magnetically ordered ultralow-temperature phase of a nuclear spin system is considered, specifically in this phase of a ferromagnetic material magnetized in the difficult plane. Such perturbations are described by the nonlinear Schroedinger equation and the problem of determining the form of coefficient Δ, generally a very difficult problem, is solved herefor the case of exact compensation of the static hyperfine field by an external field and a correspondingly maximum gap in the spectrum of nuclear spin waves. Calculation of the coefficient Δ in this case is based on the equations of macroscopic motion for nuclear magnetization m, the latter being treated as the sum of a static part m_0 and a dynamic part δm. Plane nonlinear waves of nuclear magnetization with constant amplitude are considered and, inasmuch as obviously $\Delta > 0$, the Lighthill condition for their modulational instability is shown to reduce to an inequality which yields the range of that instability and thus the range within which envelope solitons can exist. Their amplitude, width, and frequency shift are calculated on the basis of the Karpman model of such solitons (V.I. Karpman; "Nonlinear Waves in Dispersing Media", Moscow 1973) for the most realistic case of small wave numbers: $(ak)^2$ much smaller than ratio of anisotropy frequency to exchange frequency. References 6.

Peculiarities of Forming Mass-Energy Spectra of Np-238 Fission Fragments Near Barrier

927J0251A Moscow YADERNAYA FIZIKA in Russian Vol 55 No 1, Jan 92 (manuscript received 14 May 91) pp 16-24

[Article by A. A. Goverdovskiy and V. F. Mitrofanov, Institute of Physics and Energetics, Obninsk]

[Abstract] An experimental study of ^{237}Np(n,f) fission by 0.28-1.28 MeV neutrons (threshold energy about 0.7 MeV) was made using a continuous proton beam of the KG-2.5 cascade generator at the Institute and, as source of neutrons, the T(p,n)^{3}He reaction in a 1 mg/cm^2 thick T-Sc target on a water-cooled Cu substrate. The fission target was a 93+/-5 μg/cm^2 thick NpF_3 layer on a 40+/-1 μg/cm^2 thick Al_2O_3 substrate, the target material not more than 0.1 percent of others than ^{237}Np isotopes (not more than 10^{-4} percent ^{239}Pu). Fission fragments were recorded with surface-barrier semiconductor (low-resistivity n-Si) detectors and their spectra were measured by the 2E method. The data were processed in accordance with the liquid-drop model, which also yielded the mean total kinetic energy along with the variances of mass and energy distributions. Only slight corrections were required to account for scattering of fast neutrons by structural materials of the apparatus (test chamber, detectors, tritium target), presence of extraneous isotope neutrons in the laboratory, different angular distributions of Np fragments and U fragments relative to the axis of the bombarding neutron beam. The experiment has in addition yielded data about fission of ^{238}Np such as the dependence of the mean total energy of its fission fragments on its excitation energy up to the vertex of the lower outer hump of its fission barrier, also about the mass distribution of fragments and the rate of change of its variance characterizing fission of various other nuclei (Th,U,Pu,Am). Figures 7; tables 1; references 25.

Inelastic Fragmentation of Mg-24 Nucleus in Photographic Emulsion With p_0/A= 4.5 GeV/s Momentum

927J0251B Moscow YADERNAYA FIZIKA in Russian Vol 55 No 1, Jan 92 (manuscript received 3 Jul 91) pp 137-149

[Article by A. I. Bondarenko and G. M. Chernov, Institute of Nuclear Physics at UzSSR Academy of Sciences, V. V. Rusakova and Dzh. A. Salomov, Tajik State University, Dushanbe]

[Abstract] An experimental study of fragmentation of a relativistic residual ^{24}Mg nucleus in a nuclear emulsion into a nucleon and multiply charged ($Z \geq 2$) fragments was made, its fragmentation resulting from inelastic collision with emulsion nuclei with a p_0= 4.5 GeV/s momentum. Only multiply charged fragments were of concern, because of the ambiguity involved in identification of singly-charge and spectator (p,d,t) fragments by the conventional photographic method. The medium was a multilayer stack of type BR-2 emulsion (State Scientific Research and Design Institute of Chemical and Photographic Industry), its 0.06 cm thick and 10x20 cm^2 large layers having been exposed to a beam of ^{24}Mg ions with a 108 GeV/s momentum from the synchrophasotron in the High-Energy Laboratory at the Joint Institute of Nuclear Research. The primary trail scanned "along the track" over a total 292 m long path revealed 2748 events of inelastic collisions, the mean interaction length being 10.5+/-0.2 cm. For measurements were sampled nonelectromagnetic events without any discrimination regarding the number of secondary particles of any kind but conforming to the "favorable geometry", 2200 events of Mg-Em interactions having been thus measured and 3200 relativistic spectator shell fragments having been reliably identified. Their charge varied from Z= 2 to Z= 12 and their mean multiplicity varied from n_Z= 0.99+/-0.02 (Z= 2) to n_Z= 0.01+/-0.003 (Z= 12), the measurements having also yielded their transverse momentum p_T. The azimuthal correlations between fragments is analyzed on the basis of: 1) the inclusive distribution with respect to the azimuthal angle between two fragments in one event, this distribution being characterized by an asymmetry factor and a collinearity factor; 2) the distributions and the mean values of these two factors. The p_T-spectra of α-fragments reveal a "nonstatistical" excess of high values of transverse momentum, the correlation analysis indicating that this may be due to dynamic effects not included in models of direct decay. The ensemble of fragments thus evidently consists of two groups, each having a different temperatures. Considering then that the momentum and correlation characteristics of fragmentation measured in the laboratory system were appreciably distorted by the transverse momentum of fragments, for an analysis of the "true" fragmentation characteristics there had been constructed a model with the center of inertia of the decaying ensemble as reference. The results of this analysis are not inconsistent with predictions by modified statistical theory of fast fragmentation. Figures 5; tables 6; references 22.

Freedom of Parameter Choice in Scheme-Invariant Perturbation Theory

927J0220A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 1, Jan 92 pp 14-21

[Article by I. S. Parobiy, Theoretical Physics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 530.145+539.12]

[Abstract] The problem of the dependence of the theoretical predictions of the quantum field quantities on the renormalization scheme is discussed and the so-called scheme-invariant perturbation theory (SITV) which is primarily based on scheme-invariant perturbative expansions is considered. An approach first proposed by Vovk and Maksimov is further developed. To this end, a scheme-invariant expansion is derived on the basis of the running constant representation for the nondimensional physical quantity which contains two random

components. The consequences of this arbitrariness are studied and a certain nondimensional physical quantity is considered in a massless quantum field theory with a sole coupling constant α. The freedom of choice of the first random parameter *a*, the scheme-invariant series summation, and the arbitrariness of the second random parameter *A* selection are addressed. An analysis of the findings shows that the scheme-invariant physical quantity representation containing two random parameters *a* and *A* can be reduced to a series of an implicit yet well definable function. The author is grateful to S.I. Maksimov and V.I. Vovk for help and constructive discussions. References 8: 3 Russian, 5 Western.

On Nonlinear Phenomena Under Abnormal Skin Effect in Zero Magnetic Field

927J0223A Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 11, Nov 91 pp 3121-3127

[Article by A. P. Kopasov, Gorkiy Engineering Physics Research Institute; UDC 537.311]

[Abstract] The shortcomings of linear approximation for examining the conductivity and surface impedance of conductors under an abnormal skin effect in a zero magnetic field are discussed and an asymptotically accurate (under abnormal skin effect conditions) expression for the tensor of nonlinear conductivity of a third-rank conductor with a random variance law is derived allowing for the Fermi liquid interaction and spin-independent electron scattering by the impurities. The nonlinear fourth-rank conductivity tensor is calculated and it is demonstrated that when an electromagnetic wave is reflected by a conductor, the third harmonic generation may be is effective as the second harmonic generation even in the case of a large variance law anisotropy and weak nonlinearity. A fourth-rank tensor analysis shows that in general, in calculating even-ranked tensors the nonlinearity is not suppressed by the magnetic field; this means that only the purely magnetic nonlinearity is significant and the τ-approximation becomes suitable while the Fermi liquid interaction becomes insignificant. References 8.

Long-Range Action and Equations of Motion for Two Point Masses Joined by Relativistic String

927J0122B Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 89 No 1, Oct 91 (manuscript received 8 Jan 91) pp 105-120

[Article by B.M. Barbashov and A.M. Chervyakov, Joint Institute of Nuclear Research]

[Abstract] Equations of motion for two point masses joined by a relativistic string for formulated in terms of geometrical invariants of the world lines, considering that in Minkowski's three-dimensional space-time $E_2^1(t,x,y)$ the trajectory of a particle is completely determined by a pair of such invariants: curvature and twist. First are constructed equations of dynamics for a relativistic string carrying a mass at each end and moving on a Minkowski surface defined by coordinates x^μ (μ= 0,1,...,d- 1, i= 0,1). The boundary conditions are then established for the dynamics of such a string moving in Minkowski's space-time where d= 1 + 2 = 3. From this system of equations and boundary conditions for the string are then obtained equations describing the trajectories of those two point masses in the three-dimensional space-time. These trajectories have curvatures and twists due to interaction of the two masses through the string. The twists κ_i (i= 1,2) are found to be periodic, satisfying a system of second-order differential equations with deviating arguments reducible to first-order differential equations whose integration yields biquadratic polynomials with real coefficients. The curvatures k_i (i= 1,2) are found to be constant, their magnitudes depending on the string tension as well as on the magnitudes of those two masses. The world surface of such a string with a point mass at each is then readily described, inasmuch as that surface is completely determined by the trajectories of those two point masses. When the twists are constants, then a particular solution is obtained which describes rotation of a straight string with a mass at each end in some given plane. The authors thank V.V. Nesterenko and L. Rider for the stimulating discussions of pertinent problems. References 12.

Nonlinear Mechanism of Energy Transfer Between Drift Electrons in Relativistic Beam and E-Waves During Resonance Doppler Interaction

927J0157B Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 9, Sep 91 (manuscript received 23 Jul 90) pp 107-114

[Article by A. G. Bonch-Osmolovskiy and K.A. Reshetnikova]

[Abstract] A uniform magnetized relativistic monoenergetic high-current electron beam in a longitudinal quasi-monochromatic E-wave is considered, their Doppler interaction involving modulation of the beam density as a result of energy transfer between the drift electrons and the wave. The linear first stage of this interaction, characterized by energy transfer from electrons to wave and resulting amplification of the wave field, is followed by a nonlinear one during which amplification of the wave field diminishes and eventually ceases. This "resonance" stage of their Doppler interaction is analyzed on the basis of the authors' hydrodynamic model (ZHURNAL TEKHNICHESKOY FIZIKI: Vol 53 No 6, 1983; Vol 56 No 9, 1986). The initial density and velocity of the electron beam are n_0 and v_0 with the relativistic factor $\gamma_0= [1- (v_0/c)]^{-1/2}$ respectively. The amplitude of the E-wave is assumed to be slowly varying in time and its phase velocity, not equal to the velocity of beam electrons, is during this stage of interaction assumed to be slowly varying in time or space according to some a'priori stipulated law. As the kinetic energy of the beam electrons and of the beam as a whole changes during resonance Doppler interaction, the effect on the beam

depends on the velocity of the wave. Increasing nonlinearity of this interaction results in a transition from deceleration of the beam to its acceleration by a slow wave traveling with the beam at a velocity lower than initial beam velocity v_0 and a reverse transition by a fast wave traveling with the beam at a velocity higher than v_0. In a wave traveling against the beam increasing nonlinearity of interaction always enhances deceleration of the beam. The maximum power that can be transferred from a relativistic electron beam to an E-wave for maximum amplification of the wave field during resonance Doppler interaction is calculated on the basis of the energy balance. Numerical estimates based on typical electron beam parameters (I= 35 kA, γ_0= 5) parameters indicate that that the maximum power transferred to a counterpropagating E-wave (λ= 3 cm) can reach 1 MW, while the maximum power transferred to a slow E-wave during linear Doppler interaction can reach 1 MW. The authors thank A.N. Lebedev and K.N. Pazin for discussion. Figures 1; references 7.

Characteristics of Signal Division in Photoreflectance Measurements

927J0228A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 6, Jun 92 (manuscript received 30 Oct 91) pp 937-939

[Article by S. A. Grusha, A. M. Yevstigneyev, R. V. Konakova, and A. V. Sachenko, Institute of Semiconductors at Ukrainian Academy of Sciences, Kiev; UDC 621.315.592]

[Abstract] Division of photoreflection signals is analyzed, this optical method being particularly useful in study of semiconductor structures containing quantum wells and superlattices. It involves recording small relative changes of reflectance $\Delta R/R$ caused by weak modulating illumination. As an example is considered an epitaxial n-GaAs film whose absolute and relative spectra of reflectance photomodulation have been measured with a Xe-lamp as light source. For calculation of the reflection coefficient, these spectra are interpreted on the basis of three assumptions: 1) the light-induced change of slopes of bending energy bands depends logarithmically on the light intensity, 2) a depletion layer forms near an interface which reflects light, 3) the principal mechanism of reflectance photomodulation is a square-law electrooptic Franz-Keldysh effect in a weak photomodulated field of the surface barrier. The reflection coefficient in the presence of a modulating light is calculated accordingly and then is also calculated the reflection coefficient in the absence of a modulating light, the difference between them being that change in reflectance caused by modulating illumination. In measurement of the absolute photomodulation spectrum, without division of signals, ΔI is shown to be proportional to the alternating component of the luminous flux and to depend on the nonuniformity of the spectral sensitivity of the photodetector but not on the spectral distribution of the light source intensity. In measurement of the relative photomodulation, with division of signals, $\Delta I/I$ is shown to conversely depend on the spectral distribution of the light source intensity but not on the nonuniformity of the spectral sensitivity of the photodetector. Figures 1; references 7.

Streaming During Breakdown of Fine Donors in n-Ge

927J0228B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 6, Jun 92 (manuscript received 30 Jan 91; final version received 17 Oct 91) pp 914-919

[Article by N. N. Grigoryev, V. N. Yermakov, V. V. Kolomoyets, T. A. Kudykina, and L. I. Panasyuk, Institute of Semiconductors at Ukrainian Academy of Sciences, Kiev; UDC 621.315.592]

[Abstract] Streaming is proposed as a model for description of impurity breakdown in a pure semiconductor material such as n-Ge with low electron concentration, it having already been demonstrated both theoretically (E.G.S. Paige; PROGRESS IN SEMICONDUCTORS Vol 8 No 1, 1964; T.Kurosawa, H. Maeda; JOURNAL OF PHYSICS SOCIETY JAPAN Vol 31 No 3, 1971; C. Jacoboni, F. Nava, C. Canali, G. Ottaviani; PHYSICS REVIEW Vol 24 No 2, 1981) that at low temperatures the energy distribution of charge carriers in weakly doped n-Ge deviates appreciably from a Maxwellian one and the ratio of drift velocity to velocity of random motion increases as the temperature falls to liquid-helium level. The dependence of the electric breakdown field intensity E for fine donors in germanium crystals under uniaxial compression P // [111] // E_b on the mechanical pressure P was studied in an experiment with cylindrical dumb-bell crystals. Such a crystal was energized from a power supply operating as current generator so that the current could be regulated over the 0.2-100 mA range, with a stabilization factor of the order of 1000. Compression parallel to the electric field causes a split of the conduction band into three "light" valleys and one "heavy" valley, the "light" ones shifting toward higher energy levels and the "heavy" one shifting toward lower energy levels as the pressure rises. The "streaming" model is that of impact ionization of fine donors in a pure semiconductor, donor breakdown occurring at a temperature sufficiently low for a free electron to acquire the amount of energy necessary for ionizing a donor without interactions with lattice vibrations. Both the free electron and the knocked-out electron then drop to the bottom of the conduction band, from where the external electric field accelerates them again without collisions to the ionization threshold energy. The energy distribution of electrons under these conditions has a needle-like form characteristic of "streaming". On the basis of this model are calculated both recombination and ionization fluxes, breakdown occurring when both fluxes become equal. The breakdown field intensity for pure Ge under uniaxial compression parallel to the electric field does not, according to this model, depend on the pressure and this has been confirmed by the experiment. The breakdown field intensity for doped Ge under such a compression depends on the pressure as well as on the kind of impurity and on its concentration. An analysis of available experimental data on Ge:As(10^{14} cm^{-3}) and Ge:Sb($5x10^{12}$- $2x10^{14}$ cm^{-3}) indicates that: 1) at a constant impurity concentration the breakdown field intensity rises with rising pressure up to some maximum level, under 200-300 MPa, and does not rise higher as the pressure is further raised; 2) under a constant pressure the breakdown field intensity rises with increasing impurity concentration, much higher with a certain Sb concentration than with the same As concentration. Figures 1; references 11.

Optical Neurocomputers Based on Photoreactive Crystals

927J0229C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 5, May 92 (manuscript received 29 Oct 91) pp 424-440

[Article by I. M. Beldyugin, M. V. Zolotarev and K. A. Sviridov, Mechanical Problems Institute, Russian

Academy of Sciences, Moscow; UDC 519.95:535.023: 621.373.826]

[Abstract] This thorough review (based on 74 sources) gives the results of foreign and national research directed to the development of optical neurocomputers and associative memories based on photoreactive crystals. Information is given on the physical principles of interaction between laser radiation and photoreactive crystals and the principles governing realization of a completely optical neuron and systems of synapses among neurons. The teaching possibilities of different models of neuronal networks (Boltzmann machine, perceptron, associatron, neuronal networks with competition, etc.) are analyzed and optical schemes embodying these models on the basis of photoreactive crystals are analyzed. A great volume of experimental data and the results of simulation of different problems (multidimensional optimization, image recognition, etc.) by optical neurocomputers are presented. It is emphasized that the use of optical elements is a promising direction in the construction of neurocomputers. The replacement of microelectronic by optical elements will make it possible to overcome many difficulties encountered in the past. In optical neurocomputers it is possible to achieve a high density of synapses among neurons and eliminate a great many connecting links while retaining the selective transmission of signals among neurons. However, it is impossible to advance to a qualitatively new level in producing a completely optical neurocomputer without fabricating efficient high-speed matrices of optical bistable elements (neurons). Figures 16; references 74: 17 Russian, 57 Western.

Multiple States Self-Oscillatory States in Bistable Semiconductor Cavity With Competing Nonlinearities

927J0216A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 5, May 92 (manuscript received 5 Nov 91) pp 1468-1478

[Article by A. V. Grigoryants and I. N. Dyuzhikov, Institute of Radio Engineering and Electronics, Russian Academy of Sciences]

[Abstract] In the first thorough experimental study of states of self-excited oscillation in bistable semiconductor cavities with competing electronic nonlinearity and thermal nonlinearity, an InSb cavity was placed in a cryostat and excited by a CO-laser with 5.6-6 μm radiation. The specimen was a plane-parallel 5x5 mm^2 square slice 500 μm thick with a reflective gold coating on its back surface, incident radiation being focused within an about 400 μm wide spot on its front surface and the temperature in the cryostat being maintained within the 80-100 K range. The specimen was mounted in several ways so that the conditions of heat extraction and thus the characteristic thermal transient time could be varied. The initial phase mismatch δ of the cavity was also varied, over the $(-4\pi/5)$-0-$\pi/2$ range, by varying the initial dark temperature of the InSb specimen. Power measurements have yielded the quasi-static dependence of the reflected power on the incident power, the trend of this dependence in turn depending on both the initial temperature and the initial phase mismatch. The data indicate regions of thermal bistability and regions of self-excited oscillation resulting from competition of the two nonlinearities, intersection of these regions corresponding to simultaneous existence of oscillatory and stable states at a fixed incident power and a fixed initial phase mismatch. Periodic alternation of bistability and self-excited oscillation over the range of initial phase mismatch is a consequence of a periodic dependence of the radiation intensity inside the cavity on the phase shift. With certain combinations of radiation wavelength and initial temperature, states of self-excited oscillation and hysteretic transitions from one such state to another were detected in three interference orders. The experimental data are consistent with the theory (Yu.I.Balkarey, A.V. Grigoryants, Yu.A. Rzhanov, M.I. Yelinson; KVANTOVAYA ELEKTRONIKA Vol 12, 1985; Vol 14, 1987; Vol 17, 1990; OPTICAL COMMUNICATIONS Vol 66, 1988; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI Vol 13 1987). They moreover demonstrate the possibility of soft, sudden, and classical stiff loss of steady-state stability, also the possibility of the period of self-excited oscillations in four interference orders changing by purely optical action. Figures 9; references 15.

Electron and Hole States and Optical Transitions in Structure With Three Quantum Wells

927J0257A Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 56 No 5-6, May-Jun 92 pp 814-820

[Article by S. V. Voytikov, Physics Institute imeni B. I. Stepanov, Belarus Academy of Sciences, Minsk; UDC 539.293.011]

[Abstract] Semiconductor structures with quantum wells have important applications, as demonstrated by experience with structures having single and double quantum wells. A still greater diversity of properties can be expected in structures with triple coupled quantum wells. A study was therefore made of the properties of a GaAs- $Ga_{0.7}Al_{0.3}As$ mirror-symmetric semiconductor with three quantum wells in a transverse electric field. The energy spectrum of electrons and holes was computed and the parameters of interband optical transitions were determined. A mirror-symmetric profile in structures with three coupled quantum wells makes possible the partial integration into a single system of the characteristics discoverable in symmetric and asymmetric two-well structures: splitting of levels in the absence of a field and their anticrossing with the imparting of a field. The electron and hole levels and wave functions, energies of interband optical transitions and oscillator strengths of allowed and forbidden transitions are calculated numerically for fields up to 70 kV/cm. It is shown that the strongly expressed behavior

of oscillator strengths in an increasing field is attributable to the redistribution of electron and hole densities in quantum wells and changes in parities of particle wave functions. In the triple quantum well structure the anticrossing and repulsion of three levels becomes possible and new intense allowed 13H and forbidden 14H transitions appear in the absorption spectra near the band edge. Figures 4; references: 11 Western.

Diffraction of Light Beams on Decaying Ultrasound Waves in Optically Isotropic Media

927J0257B Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 56 No 5-6, May-Jun 92 (manuscript received 29 Nov 91) pp 831-836

[Article by V. N. Belyy, I. G. Voytenko and G. V. Kulak, Mogilev Division, Physics Institute imeni B. I. Stepanov, Belarus Academy of Sciences]

[Abstract] In order to optimize optoacoustic devices such as modulators, deflectors or processors it is necessary to know the influence of the polarization of incident light and the decay of ultrasound waves on the characteristics of diffracted light beams. However, research along these lines has been limited to a low intensity of ultrasound or a plane wave approximation, the decay of ultrasound waves has not been taken into account and the polarization effects accompanying the diffraction of light beams on decaying ultrasound waves have not been investigated. Accordingly, a study of the influence of polarization of incident light on the Bragg diffraction of limited light beams on decaying ultrasound waves in optically isotropic media (including crystals of cubic structure) was made. The displacement of the energy maximum of a light beam diffracted on ultrasound waves is determined. Precise solutions are found for the equations for the amplitudes of coupled waves which may be applied with any extinction coefficients or any Bragg angles. Diffraction efficiency changes with deformation of the cross-sectional profile of an incident beam are clarified. The displacement of the energy maximum of a light beam diffracted on an ultrasound wave also is described. Figures 2; references 9: 7 Russian, 2 Western.

Local Modification of Ion-Bombarded Silicon Surface With Aid of Scanning Tunnel Microscope

927J0214A St Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 18 No 7, 12 Apr 92 (manuscript received 12 Feb 92) pp 53-57

[Article by A. A. Bukharayev, F. F. Gabaydullin, A. V. Nazarov, and N. V. Berdunov, Kazan Institute of Engineering Physics imeni Ye. K. Zavoyskiy]

[Abstract] An experiment was performed involving use of a scanning tunnel microscope for local modification as well as examination of a silicon surface which had been amorphized by ion bombardment, the microscope having been interfaced with a 16/XT personal computer with the necessary data processing capability. The microscope was used in three modes of operation: 1) imaging with a direct current of about 1 nA, 2) lithography, 3) spectroscopy. Spectroscopy was done with the feedback loop open and with the distance from surface of a silicon specimen to the needle tip held constant over a period of 50 ms while the voltage was linearly raised for measurement of the current-voltage characteristic. For local modification of the silicon surface, the needle was held at a constant negative potential of 25 V over a period of 8 ms. In another procedure a modifying voltage pulse was applied at the same point on the surface where the current-voltage characteristic had been measured and at which it was afterwards measured again. The microscope needle was made of tungsten and its tip was rounded to a radius of about 30 nm. It was driven by a piezoelectric motor of cruciform "tripod" construction for scanning an up to 9x9 μm^2 large surface area, with a 0.1 nm resolution along the normal. The surface of specimens did not deviate from a planarity by more than 1 nm. Prior to their surface treatment p-Si(100) single crystals were bombarded with 30 keV Sb^+ ions in an ILU-3 accelerator, the dose of 10^{15} cm^{-2} exceeding the amorphization threshold so that about 20 nm thick a-Si surface layer would be formed. For removal of the oxide film after bombardment and prevention of subsequent oxidation under the microscope, the surface was passivated by hydrogenation in a nitrogen atmosphere. Measurements of the current-voltage characteristic made before and after treatment with an electron beam by application of a voltage pulse revealed changes identical to those effected by annealing with a thermionic tube. Estimates based on the experimental data and on a theoretical analysis of thermionic emission including a Schottky effect indicate that, with an 0.3 ev effective height of the potential barrier in the gap and with the work functions of both tungsten and silicon not exceeding 1 eV, current multiplication during recrystallization of the silicon surface layer (after it has been heated to above the 600°C threshold temperature) and attendant decrease of its electrical resistivity can pull the needle much farther away from the silicon surface. Formation of submicrometer thick high-conductivity c-Si segments on the a-Si surface could be the basis of a lithographic process useful in microelectronics. Figures 2; references 11.

Polarizational Analog Mach-Zehnder Interferometer as All-Optical Gate

927J0272A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 4(238), Apr 92 pp 363-365

[Article by V. P. Torchigin, Public Data Center at the USSR Academy of Sciences, Moscow; UDC 621.372.8.029.7:681.3]

[Abstract] The shortcomings of a nonlinear Mach-Zehnder interferometer (NIMTs)—one of the first devices designed for use as an all-optical gate—and similar drawbacks of a nonlinear Sagnac interferometers (NIS) prompted the development of an analog of the

Mach-Zehnder interferometer which is free of these defects. Interfering waves are injected in the form of a sync pulse (SI) in the same end of the optical fiber and propagate in the same direction along the principal axes of the unimodal nonlinear optical waveguide which maintains its polarization. This makes it possible to process optical logic signals entering at a very high rate and use the device as an all-optical gate. The optical trains of the Mach-Zehnder and Sagnac interferometers and the polarizational analog of the Mach-Zehnder nonlinear interferometer are cited. The interferometer is characterized by a considerably longer output signal delay than the repetition period of the input optical signals. The operations are performed in a pipelining mode, so the difference in the wavelength of input and output signals is insignificant, making it possible considerably to expand the class of all-optical gates being used. Figures 4; references 5: 1 Russian, 4 Western.

Waveguide Analog of Nonlinear Fabry-Perot Resonator

927J0272B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 4(238), Apr 92 pp 393-398

[Article by V. P. Torchigin, Public Data Center at the USSR Academy of Sciences, Moscow; UDC 621.372.8.029.7]

[Abstract] The advantages of waveguide systems for use in picosecond all-optical logic elements for today's supercomputers, particularly waveguide analogs of a nonlinear Fabry-Perot resonator (NRFP), are discussed and their comparative analysis is conducted from the viewpoint of their applications as base optical logic elements. To this end, free-running oscillations in a system of coupled waveguides and transient and quasisteady processes in coupled nonlinear waveguides are considered and known phenomena in nonlinear directional couplers are explained. A waveguide analog of the nonlinear Fabry-Perot resonator with a direct optical bias signal or a periodic sync pulse train on its input is considered in detail. The dependence of the excited wave intensity in a linear and nonlinear waveguide on the wavelength is plotted. The waveguide analog is capable of processing light pulses whose duration is shorter than that of the Fabry-Perot resonator and has individual inputs for the sync pulse and the control signals; as a result, it can have two outputs at which the input signals are represented in the direct and inverted form, thus making it easier to design logic circuits on the basis of these elements. Figures 6; references 6: 5 Russian, 1 Western.

Using Pulsed Nd-Laser to Produce Relief-Phase Holographic Optical Elements

927J0272D Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 19 No 4(238), Apr 92 pp 410-414

[Article by M. A. Gavrilova, A. S. Glebov, B. S. Guba, Z. N. Kalyashova, Yu. Ye. Kuzilin, A. G. Mikhaylova, V. S. Rykov, A. D. Starikov, V. K. Elts, All-Union Scientific Center at the State Optics Institute imeni S. I. Vavilov, Sosnovyy Bor; UDC 621.373.826:778.38]

[Abstract] The development of holographic optical elements (GOE) made possible by advances in diffraction optical elements, particularly a relief holographic structure on bichromated gelatin (BKhZh) produced by using CW lasers, are discussed and the possibility of producing a close-to-uniform recording medium surface illumination during the recording of holographic optical elements by pulsed second harmonic radiation of an Nd glass laser is assessed. The design and optical train of the holographic pulsed laser with a GLS22P Nd glass and a planar resonator, the holographic optical element recording characteristics, the properties of bichromated gelatin layers for making holographic optical elements, and the optical characteristics of the holographic optical elements are examined in detail. The spatial radiant intensity profiles at various wavelengths, the dependence of the relief depth on exposure at various spatial frequencies, and the experimental dependence of the diffraction efficiency of optical holographic element samples on the mean diffraction ruled groove depth as well as the energy distribution in two holographic optical elements are plotted. The findings confirm the possibility of using solid state pulsed lasers for making HOEs with an up to 10 cm diameter and attaining a recording surface uniformity within 10 percent at a 0.53 μm wavelength. The authors are grateful to I.B. Lisovskaya for adjusting the HOE recording system. Figures 5; tables 1; references 12: 8 Russian, 4 Western.

Schrodinger Soliton in Light Conductor With Gain and Losses: Compressed States and Noise Increase in Linear Approximation

927JO206A Moscow IZVESTIYA AKADEMII NAUK RAN: SERIYA FIZICHESKAYA in Russian Vol 56 No 4, Apr 92 pp 48-56

[Article by A. V. Belinskiy, Moscow State University imeni M. V. Lomonosov. UDC 535.14]

[Abstract] Although many studies have been made of evolution of the noise of an optical soliton in the course of its propagation in a fiber having cubic nonlinearity, the studies have shed inadequate light on the behavior of the quantum noise present, which has a tendency to increase. The objective of this study was formulation of a general approach making it possible to describe the evolution of all the fluctuating components in a light conductor with the characteristic observed gains and losses. An in-depth study was made of the evolution of quantum fluctuations of a fundamental soliton in the course of its propagation in a nonlinear fiber with the losses which occur and the gains compensating them. Simple expressions are derived for describing amplitude and phase noise, quantum indeterminacy of position and momentum, as well as fluctuations of the field quadrature components. It was established that dependence on amplification for compensating the losses is not feasible

for the effective preparation of compressed soliton states. [It is noted that after presentation of this report it was brought to the attention of the author that H. A. Haus, et al. (J. OPT. SOC. AMER. B, Vol 8, p 1122, 1991), using a somewhat different approach, obtained results which were similar with respect to gains and losses.] Figures 2; references 15: 4 Russian, 11 Western.

Fiber Optics Scanning Microscope

927JO206B Moscow IZVESTIYA AKADEMII NAUK RAN: SERIYA FIZICHESKAYA in Russian Vol 56 No 4, Apr 92 pp 193-197

[Article by L. Ginyunas, D. A. Sedykh, S. V. Shatalin and R. Yushkaytis, Vilnyus University; Radio Engineering and Electronics Institute, Russian Academy of Sciences; UDC 681.4]

[Abstract] A successful attempt was made to integrate the advantages of an optical scanning microscope and the merits inherent in fiber optics elements, such as flexibility of the light conducting channels, making it possible to integrate the sensing element into functioning equipment and to distance it from the processing units. The operating principle of the new phase-sensitive fiber optics scanning microscope is discussed and a block diagram serves as a basis for explaining the functioning of individual structural elements. The possibility of using a single-mode light conductor as a spatial filter in a confocal scheme is demonstrated. A spatial resolution of 0.8 μm was attained. A high performance of a differential microscope design in a scheme with a bimodal light conductor also was achieved. The developed fiber optics microscope has all the merits of an optical scanning microscope and is easily integrated into existing technical equipment. It is shown that such a microscope design makes it possible to obtain a longitudinal resolution up to 10 nm when there is a phase channel. A design with a bimodal light conductor for increasing the noise immunity of the fiber optics scanning microscope is proposed for obtaining differential images. Figures 4; references 11: 2 Russian, 9 Western.

Laser Deposition of High-Temperature Superconductor Films

927JO206D Moscow IZVESTIYA AKADEMII NAUK RAN: SERIYA FIZICHESKAYA in Russian Vol 56 No 4, Apr 92 pp 141-153

[Article by A. S. Kovalev, V. V. Korneyev, V. N. Okhrimenko, B. V. Seleznev, V. N. Bagratashvili, A. N. Zherikhin, A. P. Sviridov and E. N. Sobol, Scientific Research Center for Industrial Lasers, Russian Academy of Sciences; UDC 537.311.33]

[Abstract] The results of new research on the laser deposition of high-temperature superconductor films are presented. The entire process can be divided into three stages: evaporation of substance, transport of matter from target to substrate and film growth proper. All the experiments were carried out using a superconductor of the composition $YBa_2Cu_3O_{7-x}$ (YBCO). The deposition of single- and multilayer structures is described in detail. The quality of HTSC films is determined to a high degree by the parameters of the substrates. Monocrystalline substrates must be used for obtaining epitaxial films. The parameters of the crystal lattices of the substrates and film must correspond to one another. Since deposition occurs with a substrate temperature of 750°C the film and substrate must have close values of the thermal expansion coefficient. A table gives data on the majority of substrates used in deposition of YBCO films. $SrTiO_3$ and $LaGaO_3$ have lattice parameters closest to YBCO. The great difficulties involved in deposition of YBCO films on silicon are discussed. The results show that laser methods can be used successfully for the deposition of high-temperature superconductor films which in no way are inferior to films produced by other methods and the method itself allows in situ investigation of individual stages of the process and the laser deposition process does not require special preparatory procedures. Figures 5; references 36: 11 Russian, 25 Western.

Nonlinear Polarization Transformation Accompanying Degenerate Two-Beam Interaction as Method for Diagnosis of Dynamic Photochromic Media

927J0200B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 4, Apr 92 (manuscript received 19 Jul 91) pp 551-557

[Article by O. A. Kulikovskaya, V. B. Taranenko and Ye. V. Shishkalova, Physics Institute, Ukrainian Academy of Sciences]

[Abstract] A quite simple and highly sensitive method is proposed for measuring the principal parameters of dynamic photochromic media (magnitude and sign of real and imaginary parts of the complex nonlinear refractive index, nonlinearity relaxation time, diffusion coefficient, etc.), the basis for which is nonlinear polarization transformation in the case of two-beam interaction degenerate in frequency but nondegenerate in polarization. The idea of the method is that the nonlinear interaction of two beams of different polarization results in polarization transformation of these beams due to the optical anisotropy of three-dimensional lattices. As a result, for each beam at the output from a layer of photochromic material there is a change in the ellipticity and orientation of the principal ellipse axis as a function of beam intensity at the input. In this case there is no energy pumping from one beam into another because the phase shift between the interference pattern and the dynamic lattice is equal to zero. It is possible to determine the parameters of the dynamic photochromic medium by measuring the polarization ellipse parameters of one of the beams at the output. The method is applied for studying the optical nonlinearity of suspensions of purple membranes of halobacteria containing

photochromic molecules of natural and genetically modified bacteriorhodopsin. Figures 7; references 8: 2 Russian, 6 Western.

Characteristics of Fabry-Perot Interferometer With Variable Base

927J0255B Minsk VESTNIK BELORUSSKOGO GOSUDARDSTVENNOGO UNIVERSITETA IMENI V. I. LENINA. SERIYA 1. FIZIKA, MATEMATIKA, MEKHANIKA in Russian No 1, Jan-Apr 92 (manuscript received 10 Jun 91) pp 13-18

[Article by D. A. Voytovich and V. V. Mashko; UDC 535.4]

[Abstract] Although the properties of Fabry-Perot interferometers and resonators with a time-variable base have long been studied, there has been inadequate study of the form and quality of their modes. In order to fill this gap a study was made of the spectral-energy parameters of the modes of a Fabry-Perot interferometer with a linearly moving mirror. The interferometer examined was formed by two infinite parallelpiped mirrors with given reflection and transmission coefficients. One of the mirrors moves at a constant rate in the direction perpendicular to its surface. Within the interferometer near the mirror at rest there is a source of a plane polarized monochromatic wave and within the interferometer there are no radiation losses associated with absorption, scattering or other factors. A characteristic parameter defining violation of the phase condition for a stationary mode is the product of the order of the interferometer and the relative rate of change of the interferometer base. The differences in the amplitude characteristics of the proposed interferometer in comparison with stationary or quasistationary instruments are fully discussed. A series of figures supplement the text in providing information on mode and quality characteristics for the described case. The effects associated with violation of the phase condition for a stationary mode impose physical limitations on the speed of bistable optical elements. Moreover, such effects should lead to a dependence of such elements on the shape of the control pulse and its particular duration. Figures 3; references 11: 6 Russian, 5 Western.

Optimizing Interference Coatings in Adaptive Radio Optic Devices

927J0233A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 33 No 1, Jan-Feb 92 (manuscript received 27 Jun 91) pp 72-77

[Article by I. N. Sisakyan, A. V. Tikhonravov, A. B. Shvartsburg, A. V. Shepelev, and V. G. Yakushkina, Mathematics Department, Moscow University; UDC 535.317.2]

[Abstract] Recently developed fast devices to control radiation are based on field heating of free carriers of semiconductors. These devices are designed to control fluxes of radiation in the millimeter and submillimeter ranges. Their high speed as well as their ability to control the amplitude and phase of a wave makes these devices well suited for use in solving current problems in optics and laser physics in the far infrared. Elements of these devices can be optimized using special interference coatings. A qualitative calculation is done for optimizing coatings. The calculation is based on an analysis of the field dependences of the optical properties of semiconductor materials in the far infrared. The amplitude-phase characteristic of adaptive radio optic devices are calculated and it is shown that optimizing interference coatings make it possible to substantially increase (by a factor of 3-4) the dynamic range of amplitude modulation devices. Depending on the field strength, the phase of reflected electromagnetic waves can be substantial, more than two radians. This fact can be used to implement phase modulation in the far infrared and submillimeter range, as well as in systems for scanning and adaptive focusing. Figures 3; references 8: 6 Russian, 2 Western.

Doppler Interpretation of Additive Component of Speckle Noise in Adaptive Optical Systems

927J0232A St Petersburg in Russian Vol 72 No 1, Jan 92 (manuscript received 25 Apr 91) pp 176-180

[Article by V. V. Kleymenov, Military Engineering Institute imeni A. F. Mozhayskiy, St Petersburg; UDC 535.8]

[Abstract] One of the problems in synthesis of coherent adaptive optical systems is their interaction with the speckle structure of radiation reflected from an extended moving object. A study was therefore made of the case of focusing of the radiation of adaptive optical systems on the rotating diffusely reflecting surface of an object. It is shown on the basis of an analysis of the correlation function of fluctuations in the intensity of scattered radiation that the amdditive component of speckle noise is caused by a Doppler shift of the frequency of the radiation reflected from different surface points of the object (the width of the spectrum of fluctuations of the intensity of reflected radiation, the additive component of speckle noise (the multiplicative component plays no role), in the case of irradiation of the object by a plane wave is determined by the velocity of rotation of the object, wavelength and dimensions of the object, that is, its size in the plane passing through its axis of rotation and perpendicular to the observation line. The width of the spectrum of the additive component of speckle noise is evaluated on the basis of the Doppler approach in an illustrative example. [In actuality, in work with real objects the situation is still more complex because the object is not truly diffusely reflecting and the surface reflection coefficient cannot be considered constant during the time of object rotation.] References 7: 5 Russian, 2 Western.

Nonsteady-State Theory of Single-Junction Quantum Interferometer. Correlated and Compressed Coherent States

927J0212A St Petersburg FIZIKA TVERDOGO TELA in Russian Vol 34 No 1, Jan 92 (manuscript received 21 Jun 91) pp 97-102

[Article by S. T. Pavlov and A. V. Prokhorov, Institute of Engineering Physics imeni A. F. Ioffe at Russian Academy of Sciences, St Petersburg; UDC 530.145]

[Abstract] A nonsteady-state theory of a single-junction SQUID interacting with a classical oscillatory circuit in the hysteresis-free mode at low temperatures ($k_BT \leq h\Omega_0$, k_B- Boltzmann constant, h-Planck constant, Ω_0= (LC)sup-1/2, L-inductance of interferometer ring, C-capacitance of weak link) is developed which covers both correlated and compressed coherent states. It is based on the P.W. Anderson relation for the total interferometer energy, Josephson-junction energy plus weak-link energy, and its Hamiltonian. As special cases are considered steady external action with a constant external magnetic flux and an instantaneous change of frequency. The ground state of this SQUID under nonsteady action is shown to be a correlated coherent one relative to the initial state of the system, also at temperatures above absolute zero. By means of nonsteady external action such as modulation of the external magnetic flux or a frequency jump, it is shown to be possible to suppress quantum fluctuations of either the magnetic flux or the voltage with the state of this SQUID thus becoming a compressed coherent one. With this SQUID in the correlated coherent state operating in the hysteresis mode, there should take place amplification of macroscopic quantum tunneling between metastable states. References 11.

On Possibility of Using Wiedemann's Magnetostrictive Effect in Developing Adaptive Optics System Component Base

927J0219A St Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 11, Nov 91 pp 112-124

[Article by V. I. Aksinin, V. V. Apollonov, S. V. Muravyev, A. M. Prokhorov, S. A. Chetkin, General Physics Institute, Moscow; 05; 06]

[Abstract] The possibility of developing controllable-attitude mirrors with a real-time relief variation law of the reflecting surface on the basis of spring-type precision actuators which realize Wiedemann's magnetostrictive effect and have a unique combination of displacement characteristics is investigated and the principle of magnetomechanical energy conversion by means of developing torsional strain in a ferromagnetic rod is considered. The forces, moments, and magnetic fields developing in the magnetostrictive spring-type actuator (MAPT) and its representative amplitude-frequency (AChKh) and phase-frequency (FChKh) characteristics are plotted. An *XY* MAPT-based reflecting surface dynamic positioning device, i.e., an electromechanical scanner (EMS) used to correct the wave front (VF) slope is considered and the effect of the feedback loop on its amplitude-frequency response is examined. A precision linear stepping motor (ShLD) designed on the basis of spring-type magnetostrictive actuators is described and its timing chart is cited. The devices developed on the basis of MAPT's confirm the efficiency of using them for developing adaptive optics actuators and controlling the shape of the cooled adaptive laser mirrors. The authors are grateful to V.I. Andryushin, V.V. Ostanin, A.S. Borodin, A.S. Brynskiy, V.A. Chizhevskiy, and A.V. Shemshurin for assistance. Figures 9; references 11: 8 Russian, 3 Western.

X-Ray Radiation Focusing Using Variable Section Waveguide

927J0219B St. Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 11, Nov 91 pp 125-133

[Article by V. I. Glebov, E. I. Denisov, N. K. Zhevago, Atomic Energy Institute imeni I. V. Kurchatov, Moscow]

[Abstract] The need for X-ray beams with a 1 μm^2 cross section and a sufficiently high intensity and the shortcomings of waveguides with a constant cross section for focusing them prompted an investigation of the X-ray propagation in a waveguide with a gradually changing cross section; in so doing, attention is focused on the attainable upper limit of photon flux density as a function of the waveguide geometrical parameters, the reflectance of its walls, and angular divergence of the primary photon beam. The theory of X-ray radiation propagation in a variable cross section waveguide is developed and the dependence of the coefficient β which determines the glass surface reflectance at low angles on the radiation frequency is plotted. The experiment design is described and the X-ray photon flux distribution in the exit angle from a wedge-shaped waveguide is examined. A fifteen-fold flux density increase is attained at a low X-ray beam divergence angle. The multibeam radiation character at the waveguide outlet is noted. It is stressed that expanding wedge- or cone-shaped waveguides may be used for significantly decreasing the angular divergence of beams whose initial divergence is commensurate with the critical angle. Figures 4; references 14: 7 Russian, 7 Western.

Parametric Soliton Resonance in System of Tunnel Coupled Optical Fibers

927J0219C St Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 11, Nov 91 pp 217-219

[Article by S. A. Darmanyan, Thermal Physics Department at the Uzbek Academy of Sciences, Tashkent]

[Abstract] A system of two tunnel coupled nonlinear waveguides first examined by Jensen and Mayer is considered from the viewpoint of using it in the soliton mode and the specific case where the parameter describing the coupling of two optical fibers is a function of the coordinate along the fiber length is investigated. A system of equations which describes the propagation of optical pulses in coupled fibers—a system of two nonlinear Schroedinger equations (NUSh)—is derived and the perturbation theory is used in an adiabatic approximation, assuming that that coupling factor magnitude is much less than unity, to demonstrate that for solitons of an equal amplitude, the interaction potential depends on the initial soliton phase difference which is equal to 0 or π. Two particular cases of the dependence of the coupling factor ε on the coordinate x are examined. It is shown that in a system of tunnel coupled optical waveguides (fibers) with variable coupling, both the parametric and stochastic parametric soliton resonance can be realized; this resonance is manifested in an exponential increase in the mutual oscillation amplitude of the soliton center positions and relative velocities. A closed equation is derived for the phase difference. It is demonstrated that there is a domain in the tunnel coupled fiber system with a modulated coupling where the stochastic soliton dynamics develop. References 10: 6 Russian, 4 Western.

Optoelectronic Embodiment of Hopfield Model for Neuronal Network Based on Holographic Photothermoplastic Disk

927J0231B Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321 No 2, Nov 91 (manuscript received 10 Sep 91) pp 302-305

[Article by A. A. Akayev, academician, Kirgiz Academy of Sciences, B. D. Abdrisayev, S. Z. Dordoyev and A. A. Kutanov, Physics Institute, Kirgiz Academy of Sciences, Bishkek; UDC 681.51:681.3]

[Abstract] An optoelectronic embodiment of the Hopfield model (PROC. NAT. ACAD. SCI. USA, Vol 79, pp 2554-2558, 1982) was developed for a neuronal network which makes use of a holographic photothermoplastic disk. This article gives the results of experimental work and computer simulation of its construction and functioning. An annotated diagram is used in explaining different components, links and interactions in the system, followed by a specific example of its application. Network operation was simulated using an IBM PC. It was found that with teaching of the network using the Hopfield model with an increase in the number of stipulated input vectors there is a considerable decrease in the probability of recognition. For example, in computer simulation of the process of recognition of letters in the Kirgiz alphabet it was found that already with four images there was a sharp increase in the possibility of appearance of an erroneous result. However, it was found that this problem can be solved by using a multilevel association algorithm. An alternative, preferable way to overcome shortcomings in the Hopfield model is the use of an interimage association algorithm. The proposed variant can be regarded as a neurocomputer for the associative processing of information in large high-speed databases. Figures 3; references 5: 1 Russian, 4 Western.

Pairs of Bound Diffraction Autosolitons in Interferometer With Threshold Nonlinearity

927J0194A Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 71 No 5, Nov 91 (manuscript received 19 Apr 91) pp 816-819

[Article by N. N. Rozanov, State Optical Institute imeni S. S. Vavilov, Leningrad; UDC 535.81]

[Abstract] Spatial field structures in distributed nonlinear optical systems may arise in two ways. In the first there is a smooth change in the controlling parameter and the smooth field distributions may become unstable, whereas in the other variant spatial structures arise with conservation of the stability of the initial smooth field distributions. Formation of the latter requires an initial large field surge (so-called hard excitation). Diffraction autosolitons (DAS) are an example of such structures. These are particle-like field structures in a nonlinear interferometer excited by external radiation. Their analysis is quite difficult and numerical computations are required for different forms of nonlinearity. An analytic approach was proposed earlier by the author in OPT. I SPEKTR., Vol 69, No 6, p 1215, 1991 for the case of a nonlinearity of the threshold type. Such an approach makes it possible to study some properties of DAS which are difficult to extract from direct numerical computations. This article, a continuation of the study cited above, is an analytic examination of the bound states of two DAS. It was found that there is a "hard" character of DAS (a slight dependence of their width and configuration on their surroundings) and a splitting of the widths during the interaction of DAS. This finding makes possible simple approaches for constructing multiparticle DAS configurations. With an increase in the number of DAS in a multiparticle structure the spectrum of their widths approaches continuous (zonal). Figures 2; references 8: 3 Russian, 5 Western.

Fractals in Quantum Theory: Analytical and Numerical Approaches

927J0122A Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 89 No 1, Oct 91 (manuscript received 29 May 91) pp 73-79

[Article by P. K. Silayev, Ye. N. Tyurin, and O. A. Khrustalev, Scientific Research Institute of Nuclear Physics at Moscow State University]

[Abstract] A quantum dynamics system is constructed which explicitly reveals its fractality, considering that the analytical sense of quantum dynamics is the behavior of the mean value of a certain vector operator A as a function of time: $A_{mean}(t)= Sp[\rho A(t)]= \Sigma_{m,n} \rho_{mn}A_{nm}exp[i(E_m- E_n)t/h]$ ($E_{m(k)}$,$E_{n(k)}$ energy levels, m,n- numbers identifying Hamiltonian eigenfunctions, $\rho_{m(k)n(k)}$- density matrix, Sp- trace of density matrix, k- integer). It is assumed that for any integer k there can be found two energy levels $E_{m(k)}$ and $E_{n(k)}$ such that $(E_{m(k)}- E_{n(k)})/h= \omega_0 k$, examples being a harmonic oscillator and a potential well with boundless walls. A density matrix of the form $\rho_{mn}= \rho_{m(k)n(k)}= b_k e^{\beta(k)}$ and a vector operator correspondingly of the form $A_{n(k)m(k)}$ are chosen, such a density matrix of wave functions requiring an additional degree of freedom. Considering further only two-dimensional quantum mechanics with a potential $V(x,y)= V(x)+ W(y)$, where V(y) is the original potential and W(y) is an arbitrary potential with a discrete spectrum, it will be assumed that W= V. A system of "fractal quantum dynamics" is constructed on this basis for a potential well $V(x,y)= x^2/2 + y^2/2$ with an operator $A= exp(va^+) + exp(va^-)$ (v- arbitrary constant, a^+- oscillation generation operator, a^- oscillation annihilation operator) and for a two-dimensional harmonic oscillator. The state of the latter, now described by a wave function, ensures a "fractal" behavior of the mean value of operator A. The thus constructed system of "fractal quantum mechanics" makes it possible to construct any Koch curve with a Fourier series expansion. Numerical estimation of the fractal dimensionality involves generating a data array of values of the sought vector variable r_k at instants of time $t_k= k\delta t$, followed by calculation of the correlation sum S. The fractal dimensionality or, more precisely the correlation dimensionality, will then be the slope of the $\log(S)/\varepsilon$ curve (ε- vector constant signifying the dimension of a neighborhood). It may be more expedient to replace the sum S with the D-fractal correlation sum (D- embedded dimensionality). References 7.

Study of Localized Deformation by Methods of Scanning Microscopy

927J0168A Riga LATVIISKIY FIZIKO-TEKHNICHESKIY ZHURNAL in Russian No 5, Sep-Oct 91 (manuscript received 5 Jun 91) pp 65-71

[Article by D. Z. Grabko, Yu. S. Boyarskaya, T. A. Nazarova, M. V. Nazarov, and E. I. Rau, Institute of Applied Physics, Moldovian Academy of Sciences]

[Abstract] Local deformation of ionic crystals under a diamond-point indenter was studied with plain and polarized 632 nm light of an He-Ne laser beam under a JSM-50A scanning transmission electron microscope of the multipurpose diagnostic testing apparatus built at the Department of Physics at the Moscow State University. For scanning with polarized light, this microscope operated with U-modulation of the contrast and thus, without use of a Berek compensator, yielded a graphic display of the contrast amplitude distribution as an indicator of the stress distribution function along both birefringence paths. Three varieties of such crystals with identical NaCl-type lattices and 110 slip indices but widely differing in hardness were thus examined: KCl (hardness 100 MPa), LiF (hardness 1200 MPa), MgO (hardness 8000 MPa), these hardness readings presumably referring to room temperature. A crystal of each variety was indented on its (001) face with a Vickers diamond pyramid under various loads covering the 0.5-5.5 N range. Indentations were made at various temperatures covering the 77-800 K range so as to correspondingly vary the hardness of the crystals, for the purpose of determining the dependence of the deformation pattern in each crystal on the hardness of that crystal. Standard etchants were used for revealing the dislocation structure which had formed around an indenter imprint. Scanning a crystal with a nonpolarized laser beam for the first time revealed transmission contrast patterns indicating the presence of a superdefective zone in the immediate vicinity of the indenter imprint, both appearance and size of this zone depending on the crystal hardness and on the temperature at which the indentation has been made. Scanning with a polarized laser beam revealed, without a Berek compensator, the distribution of residual stresses within the birefringence regions around the indenter imprint. Development of the deformation pattern thus evidently depends on the hardness of these crystals in the order KCl < LiF < MgO and on the mobility of dislocations in them. Figures 3; references 12.

Viscosity and Ionic Sound in Superdense Plasma

927J0227A Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 30 No 3, May-Jun 92 (manuscript received 26 Nov 91), pp 444-448

[Article by I. T. Yakubov, Scientific Experimental Institute of High Temperatures at Russian Academy of Sciences; UDC 533.932]

[Abstract] Nonideal plasma is considered in which there take place weak electron-electron interactions, moderate electron-ion interactions, and strong ion-ion interactions. A strongly nonideal superdense plasma, which forms following incidence of a high-intensity energy flux on a condensed matter and in which multiple ionization then takes place, is of particular interest. Its viscosity of such a plasma and the attenuation of ionic sound in it are calculated by extending the theory of ionic sound in a moderately nonideal gaseous plasma. In such a plasma ionic sound is attenuated principally by viscous drag and remains adiabatic, Joule heat playing no significant role and electronic sound remaining isothermal. As the ion-ion interactions become stronger, the plasma becomes liquid-like and then at the limit its ionic subsystem crystallizes. The viscosity of such a strongly nonideal plasma is calculated on the basis of methods of molecular dynamics and vacancies are shown to become the agents of momentum transfer in it, while the region of the phase space occupied by viscous sound becomes narrower. The attenuation of ionic sound in a superdense plasma is calculated on the premise that the electronic subsystem becomes an almost ideal gas and its pressure becomes essentially the total pressure when electron-electron interactions are very weak so that Joule heat becomes a significant factor in a plasma with a very high ionic charge. Figures 1; references 9.

Self-Sustained Oscillations Excited by Electron Beam of Finite Radius in Plasma Without Magnetic Field

927J0218A Moscow FIZIKA PLAZMY in Russian Vol 18 No 5, May 92 pp 618-626

[Article by V. P. Kovalenko, I. M. Parneta, Physics Institute at the Ukrainian Academy of Sciences; UDC 533.932]

[Abstract] Self-sustained oscillations excited in a longitudinally infinite beam plasma system due to its finite radial dimension are considered in the case where the electron beam is injected into plasma without a magnetic field and the self-sustained oscillations excited under steady-state injection of a radially bounded electron beam into the plasma half-space in the absence of magnetic field are analyzed. A field equation in a radially bounded system is derived and the longitudinal and transverse charge structure in plasma as well as the anticipated shape of the spatial dependence of the electric field and charge are plotted. Self-excited oscillation equations are derived for thin electron beams in plasma and the axial dependence of the field and current amplitude is examined. The study demonstrates that self-sustained oscillations may be exited in plasma under radial beam dimension limitations even without a magnetic field; the beam serves as a source of field in the entire space. At certain frequencies, beam charge bunches which form in plasma excite a field whose amplitude and phase facilitate the generation of such clusters, so the system becomes self-organized. Figures 4; references 7.

Nonlinear Kinetic Wave Excitation in Local Alfven Resonance Region

927J0218B Moscow FIZIKA PLAZMY in Russian Vol 18 No 5, May 92 pp 660-663

[Article by V. I. Lapshin, K. N. Stepanov, V. O. Shtrasser, Kharkov State University; UDC 533.951]

[Abstract] The nonlinear phenomena, parametric plasma instability and turbulence, and turbulent heating resulting from an increase in the electric field amplitude near the local Alfven resonance, i.e., an electromagnetic wave conversion to a kinetic Alfven mode, is discussed and the electromagnetic wave conversion in the area of local Alfven resonance in the presence of both a spatial dispersion and a striction nonlinearity is investigated. Such effects are significant under plasma heating by Alfven waves in stellarators and tokamaks as well as in the problem of maintaining a steady-state current in a tokamak by exciting waves at frequencies below the ion cyclotron frequency. A system of Maxwell's equations is derived assuming that the plasma density in the resonance area changes linearly; the electron inertia is ignored. The system is solved numerically and the dependence of the solution on the coordinate x is plotted. The curves demonstrate that the presence of nonlinearity leads to a resonant point shift toward the plasma edge and an increase in the number of points, a decrease in the maximum amplitude and space field oscillation period, and the appearance of a long-wave modulation which increases with the field amplitude. Thus, strictive nonlinearity leads to the formation of a highly nonlinear kinetic Alfven wave near the local Alfven resonance. Figures 3; references 4: 3 Russian, 1 Western.

One Class of Precise Solutions of Kinetic Model of Plasma Equilibrium

927J0198A Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 91 No 1, Apr 92 (manuscript received 22 Jul 91) pp 129-141

[Article by Yu. A. Markov, Irkutsk Computer Center, Siberian Department, USSR Academy of Sciences]

[Abstract] It is shown that a Vlasov-Maxwell system has interesting and physically significant stationary states which are described by a system of elliptical equations

with exponential nonlinearities on the right-hand side. For a two-component nonrelativistic system the problem was reduced to an equation of the sh-Gordon type. The parameter on which the form of this equation is essentially dependent is the charge of the ion component of plasma. For example, for hydrogen plasma this equation will be an sh-Gordon equation. For helium plasma the equation is considerably more complex, a Bullough-Dodd-Jiber-Shabat (BDJS) equation. In solving the latter equations use is made of the R. Hirota method (J. PHYS. SOC. JAPAN, Vol 33, No 5, pp 1459-1463, 1972), which can be applied to the elliptical operator. Application of this method to the sh-Gordon equation makes it possible to obtain a precise solution in a quite general form, whereas for the BDJS equation it ensures only an algorithm for a set of particular precise solutions of increasing complexity. As an example, the precise solution which is obtained in retrieving such plasma characteristics as the distribution function and electromagnetic field is given. References 24: 19 Russian, 5 Western.

Spectral and Dispersion Properties of Paired Soliton States in Quasi-One-Dimensional Anisotropic Antiferromagnetic Material With S = 1/2

927JO198B Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 91 No 1, Apr 92 (manuscript received 24 May 91) pp 112-119

[Article by S. N. Martynov, Physics Institute imeni L. V. Kirenskiy, Siberian Department, USSR Academy of Sciences]

[Abstract] The thermodynamic properties of low-dimensional magnetic systems are fundamentally dependent on the type and intensity of the interactions responsible for their three-dimensional ordering. In the case of a triangular arrangement of the chains antiferromagnetic exchange between the closest chains in the quasi-one-dimensional Ising model results in a frustration of exchange and as a result, a complex character of the transition to a three-dimensionally ordered state. Interactions become operative in which a transition to an ordered state occurs in two stages. These interactions exert a very great influence on the form of excited states in such systems, especially at near-critical temperatures. The spectral properties of such states, directly measured in resonance research, carry important information not only on the character of the excitations, but also on the specifics of magnetic ordering. It is now demonstrated analytically by solution of the Shrodinger equation in a continuous approximation that there are natural excited states of a quasi-one-dimensional Ising antiferromagnetic with a spin S = ½ in the form of spatially localized quantum states. Computer simulation of a discrete model of interacting solitons with allowance for symmetry of the solutions gives the eigenvalues of a Sturm sequence differing from solutions in the continuous approximation. The spectral and dispersion characteristics of lower-energy nonlinear bound states and selection rules for resonance transitions in an external magnetic field imparted parallel and perpendicular to the magnetic anisotropy axes are computed. Figures 4; references 9: 2 Russian, 7 Western.

Mean Velocity of Randomly Accelerated Charged Particle

927J0214B St Petersburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 18 No 7, 12 Apr 92 (manuscript received 30 Dec 91) pp 63-66

[Article by V. M. Loginov]

[Abstract] Random acceleration of charged particle with mass in a randomly nonuniform electric field is analyzed on the basis of the one-dimensional model of the acceleration dynamics, assuming that the electric field is an analog of a Gaussian noise with an arbitrary law of correlation decay. Expressions are obtained for the mean velocity of a particle in transit and of a particle entrapped, taking into account appropriate initial and boundary conditions. The evolution of their mean velocity indicates that such an acceleration of charged particles is analogous to propagation of heat through a semi-infinitely long beam with one end held at a constant temperature. It also indicates how random acceleration can transform random motion into an oriented one. References 6.

Results of Experimental Studies Concerning Nonlinear Interaction of Strong Short-Wave Signals in Ionospheric Plasma

927J0214C St Petersburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 18 No 7, 12 Apr 92 (manuscript received 27 Jan 92) pp 69-72

[Article by S. A. Dmitriyev, Yu. A. Ignatyev, G. S. Korotina, P. B. Shavin, and Yu. Ya. Yashin]

[Abstract] Nonlinear interaction of strong short electromagnetic radio- frequency waves in the ionospheric plasma was studied experimentally at night during the period from 20:00 h local (Moscow) time on 28 May 1991 to 09:00 h on 29 May 1991 and at daytime during the period beginning from 09:00 h on 29 August 1991. Tests were performed with the aid of the "Sura" test facility at the Scientific Research Institute of Radiophysics. Both frequencies f_1 and f_2 of two interacting waves were of the order of the critical f_0 F2-layer frequency. Both waves, polarized as usually, were sent vertically up. At the f_1 frequency the "Sura" apparatus operated in five min cycles (three min on - two min off) with a 500 kW transmission power. At the f_2 frequency it operated in 12 min cycles (15 min on - five min off) with a transmission power changed every 20 min in 1 h cycles of 10 kW - 50 kW - 250 kW. During simultaneous transmission at both f_1= 9.31 MHz and f_2= 4.785 MHz frequencies interaction of both waves was found to have produced a

difference-frequency f_3= 4.525 MHz signal with an amplitude 10-20 dB above noise level, no such signal having been detected during transmission at only one of the two frequencies. No buildup or relaxation of that signal was observed after 0.1 s, indicating passage of the f_2 (higher frequency) signal through the ionosphere without reflection and an interaction without time lag. The amplitude of the f_2= 4.785 MHz signal reflected by the ionospheric layer increased by 3-10 dB after the f_1= 7.815 MHz "Sura" transmitter had been turned on and then decreased after that transmitter had been turned off, both buildup and relaxation of that amplitude occurring within a one min lag time. Interaction of two waves in the ionospheric plasma evidently involves transfer of energy from the higher-frequency wave to the difference-frequency wave in the first case and to the lower-frequency wave in the second case. Figures 2; tables 1; references 7.

Absolute Calibration of X-Ray Spectrometer in Synchrotron Radiation

927JO196A Moscow FIZIKA PLAZMY in Russian Vol 18 No 4, Apr 92 (manuscript received 18 Apr 91) pp 479-481

[Article by Yu. M. Goryachev, I. I. Kutuzov, N. V. Lunin, L. Ye. Mstibovskaya, D. G. Odintsov, L. G. Rabinovich, Ye. P. Stepanov and M. A. Terekhin, Applied Physics Institute, Russian Academy of Sciences; Burevestnik Scientific Production Association; Atomic Energy Institute imeni I. V. Kurchatov; UDC 621.317.7]

[Abstract] Data are given on the absolute calibration of the RAD spectrometer in a beam of synchrotron radiation. The X-ray-optical structure of the instrument includes two parabolic cylinders with curved crystals mounted in such a way that their foci coincide and their axes are antiparallel. The radiation passing through a first diaphragm is incident on the first crystal and after reflection the diffracted waves, passing through the common focus F, are incident on a second crystal with the same Wulff-Bragg conditions. Then the monochromatic rays are propagated parallel to the optical axis in the direction of a detector. Mica, quartz, RbAP and LiF crystals, positioned in three stages of the parabolic cylinder, were used as crystal-analyzers. In this spectrometer the working range is 1.45-25 A. A slit at the F focus reduces the level of scattered radiation. Using such a setup the dependence of the number of signal pulses at a wavelength 16 A on current strength was determined. A similar dependence also was obtained for other wavelengths and the conclusion therefore is drawn that there is a linearity of the number of pulses from the current within the limits of some dispersion. The dependence of the number of signal pulses per photon of X-radiation of different polarizations was determined for mica, quartz and RbAP. The accuracy of the calibration is evidently 40-100 percent at the most reliable points of the spectrum, although it is cautioned that the results are preliminary. Figures 3; references 6: 3 Russian, 3 Western.

Multilayer Mirrors for Soft X-Radiation

927JO196B Moscow FIZIKA PLAZMY in Russian Vol 18 No 4, Apr 92 (manuscript received 18 Apr 91) pp 482-484

[Article by E. P. Kruglyakov, M. V. Fedorchenko and N. I. Chkhalo, Nuclear Physics Institute, Siberian Department, Russian Academy of Sciences; UDC 621.317.7]

[Abstract] The parameters of multilayer X-radiation mirrors prepared using an ultrahigh-vacuum apparatus with the laser deposition of target materials are discussed. The first experience with use of the mirrors for the selective registry of soft X-radiation in experiments with the heating of plasma using highly precise relativistic electron beams are described. Data are given on the reflective properties of multilayer X-radiation mirrors based on nickel-carbon and titanium-beryllium pairs in the range of photon energies 90-280 eV and 8 keV. The materials were deposited using a neodymium laser with quality modulation operating at a repetition rate 1 Hz. The standard power of a single pulse was 3 J. During the deposition process this power was maintained constant from pulse to pulse with an accuracy to 3-5 percent. The substrata materials used were silicon and optical glass. The deposition procedure involved forming a multilayer sandwich from a pair of periodic table elements. In the photon energy range 30-800 eV the mirror characteristics were studied by means of an X-ray spectrometer with a camera attachment making it possible to study the dependence of the mirror reflection coefficients on angle in the range of glancing angles 0-80 degrees. The pertinent mirror parameters for Ti-Be and Ni-C pairs are given in a table. The results of the preliminary experiments show that by using such mirrors it is evidently possible to measure electron temperature beginning with 10-20 eV with a plasma density 10^{14} cm^{-3}. Figures 2; references 4: 3 Russian, 1 Western.

Electric Detonation of Frozen Deuterium Filaments

927JO196C Moscow FIZIKA PLAZMY in Russian Vol 18 No 4, Apr 92 (manuscript received 26 Feb 91, after revision 17 Oct 91) pp 517-528

[Article by N. A. Bobrova, T. L. Razinkova and P. V. Sasorov, Theoretical and Experimental Physics Institute; UDC 533.9]

[Abstract] In a wide range of parameters a theoretical study was made of the dynamics of z-pinches formed during the electric detonation of frozen deuterium filaments. Analytic evaluations were made, as well as numerical computations based on a specially developed program. The transition observed with a change in parameters between the dissipative regime observed in recent experiments and in the classical regime of the dynamics of z-pinches is investigated. A simple analytic description of a dissipative regime in the stage of quasistationary expansion of the pinch is obtained which is consistent with the results of numerical computations.

Allowance for all dissipative processes in the electron component of plasma is important. In the entire investigated region such a pinch has a heterogeneous structure. Formulas are derived which determine the type of pinch dynamics regime. It is shown that the dynamics of dense z-pinches differs from the dynamics of classical z-pinches. For dense z-pinches a major role is played by dissipative processes: Joule heating, thermal conductivity and radiation. The physical processes responsible for the appearance of heterogeneous states are clarified. Various experiments, past and projected, cover all the investigated regimes, which opens the way for detailed comparisons. Figures 7; references 19: 14 Russian, 5 Western.

Obtaining Beams of High-Energy Electrons in Medium and High Pressure Gases

927J0235B Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 35 No 2, Feb 92 (manuscript received 14 Nov 90; after revision 10 Apr 91) pp 7-9

[Article by V. S. Korolev and A. N. Maltsev, Institute of Atmospheric Optics, Siberian Division of the Russian Academy of Sciences; UDC 537.52]

[Abstract] The possibility of obtaining high-current beams of high-energy electrons is studied as applied to the acceleration interval of voltage pulses with nanosecond lengths and amplitudes up to 300 kV. The pressure in the gas intervals (helium, nitrogen) varied from 10^{-1} Torr to atmospheric pressure. Experiments showed that the placement of two barriers in the acceleration gap makes it possible to significantly increase the current of electron beams by increasing the combustion time of a three-dimensional discharge when the electric field is in an extreme overvoltage condition. The position and number of barriers was determined through lengthy experiments. The first was placed $0.2l$ from the cathode (l is the acceleration interval), and the second was placed up against the anode array. The Dacron barriers were 65 μm thick. Electron beams with energies up to 250 keV and current up to 260 A were obtained. Figures 2; references 6 (Russian).

Ion Instabilities in Hall Plasma

927J0207A Moscow FIZIKA PLAZMY in Russian Vol 18 No 1, Jan 92 (manuscript received 18 Apr 91) pp 3-8

[Article by A. V. Gordeyev and A. V. Grechikha, Atomic Energy Institute imeni I. V. Kurchatov; UDC 533.9]

[Abstract] Under certain conditions the applicability of the hydrodynamic approximation becomes inapplicable for plasma. The Hall effect becomes operative and the plasma becomes essentially a two-fluid medium. This article describes instabilities in Hall plasma with allowance for ion dynamics and the finite character of the electron mass. The physical reason for the instability is the existence of the Hall effect. In plasma with homogeneous density the term with the Hall effect disappears from the equations and the Hall effect is manifested only in the near-electrode region. On the other hand, with a high value of the Hall parameter even a small density gradient associated with the motion of ions is adequate in order for the Hall effects to exert a substantial influence on the dynamics of the developing perturbations. After a discussion of Hall convection as a source of two-fluid instability a linear theory of the two-fluid dynamics of Hall plasma is formulated. For plasma with a small linear ion number it is evident that there is a universal mechanism leading to strong two-fluid instability with a maximum increment on the order of $(\omega_{Hi}\omega_{He})^{1/2}$. It is shown that except for cases of quite homogeneous plasma with small gradients of magnetic pressure Hall plasma is unstable due to the destabilizing influence of magnetic field drift. Practical applications of these findings are discussed. References 9: 8 Russian, 1 Western.

Excitation of Nitrogen Electron Levels in Low-Pressure Gas Discharge in Very Intense Microwave Field

927J0207B Moscow FIZIKA PLAZMY in Russian Vol 18 No 1, Jan 92 (manuscript received 11 Apr 91, after revision 17 Jul 91) pp 124-127

[Article by O. A. Ivanov and S. F. Lirin, Applied Physics Institute, USSR Academy of Sciences; UDC 537.56]

[Abstract] The results of computations of the coefficient of excitation of electron levels of nitrogen molecules in a very intense microwave field are presented. The most important constants in this process are examined. For example, a formula is derived which gives the averaged value of the constant corresponding to the interaction of a molecule with an electron moving with the translational velocity u and oscillating in the external field E cos ωt. By changing the u parameter it is possible to compute the values of the constants corresponding to different translational velocities of electrons in the discharge. The results of the computations are the minimum and maximum values of the constants for all possible u in a stipulated range with a given E/ω value. A comparison of the values of the ionization constant for nitrogen and argon obtained within the framework of the presented approximations with earlier computations and experimental results indicated their quite good agreement. The method can be used in evaluating the constants of other kinetic processes in the plasma of a microwave discharge. The computations were made for the most characteristic discharge processes in nitrogen, determining its kinetics and making the greatest contribution to the emission of the discharge plasma. The results of computations of the minimum and maximum values of the constants of different processes are given in several figures. These show that with a breakdown in a very intense microwave field the efficiency in excitation of most electron levels decreases with an increase in electric field amplitude. However, the excitation constants

decrease with an increase in the oscillatory energy of electrons considerably more slowly than the section of the corresponding process changes. Those levels are most efficiently excited whose excitation section decreases with an energy increase. Figures 2; references 11: 6 Russian, 5 Western.

Bessel Beams of Electromagnetic Waves: Self-Action and Nonlinear Structures

927J0094B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 6 (12), Dec 91 (manuscript received 15 Oct 90) pp 1756-1766

[Article by N. Ye. Andreyev, Yu. A. Aristov, L. Ya. Polonskiy, and L. N. Pyatnitskiy, Institute of High Temperatures, USSR Academy of Sciences]

[Abstract] Propagation of Bessel beams of electromagnetic waves through nonlinear media following breakdown of a gas is considered, such beams being used for producing continuous long laser sparks. The self-action of such a beam in media with various kinds of local or nonlocal nonlinearities is analyzed theoretically on the basis of an equation for the complex amplitude of a stationary cylindrically symmetric electric field E(r,z), for a complex amplitude which varies slowly along the beam. The medium is assumed to have a linear dielectric permittivity $\varepsilon = \varepsilon_0 + i\varepsilon'' + \varepsilon_{NL}(|E^2|)$ (ε_0- real part; ε''- imaginary part, responsible for tapering the field; ε_{NL}- nonlinear part, dependent on the field intensity and determined by the nonlinear material equations describing the medium). This equation, upon normalization of the field amplitude E to the characteristic field amplitude E* corresponding to a given kind of nonlinearity, has been solved numerically for media with power-law nonlinearities such as a plasma or a Kerr liquid and also for media with nonlocal nonlinearity. The calculations made for a Bessel beam in a medium linearly absorbing laser radiation reveal a beam structure not much different than that in a dissipationless medium. The calculations made for a Bessel beam in a medium with local cubic nonlinearity and thus one without saturation reveal a spatially periodic beam structure, also self-modulation of the beam when the radiation power is approximately equal to the critical one within the subthreshold range of beam intensity. The calculations made for a Bessel beam in a medium with local higher-order nonlinearities also reveal a spatially periodic structure and occurrence of self-modulation under analogous conditions. The calculations made for a Bessel beam in a medium with nonlocal nonlinear response reveal analogous but nonlinear periodic beam structures. The beam structure is found to become more intricate as the beam intensity in a medium with nonlocal nonlinearity and in a medium with local quadratic and thus saturable nonlinearity increases, large-scale modulation then building up alongside small-scale modulation. These theoretical results were verified experimentally with axicon focusing of electromagnetic radiation into beams with a Bessel-function radial intensity profiles for production of continuous long laser sparks. Such experiments were performed with four different Nd-lasers (a single-frequency one and three single-mode ones) emitting each electromagnetic 1.06 μm radiation in pulses of 1-50 ns duration with 1-30 GW power. Breakdown of the gas and subsequent formation of a plasma channel for a continuous long laser spark were tracked in He, Ne, Ar, Xe, CO_2), and in air, under pressures ranging from 5 kPa to 1 MPa. The original laser beams were hyper- Gaussian with M= 5-8, and various different axicons were used so that the focusing angle could be varied from 2.5° to 10°. Figures 5; references 17.

Nonlinear Mixing During Propagation of Two-Frequency Wave Beam Through Magnetized Nonhomogeneous Plasma

927J0124A Moscow FIZIKA PLAZMY in Russian Vol 17 No 11, Nov 91 (manuscript received 6 Feb 91) pp 1297-1302

[Article by L. M. Gorbunov and A. V. Romanov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences; UDC 533.951]

[Abstract] Nonlinear interaction of two plasma waves with a small frequency difference forming an axisymmetric beam which propagates along the z-axis through a nonhomogeneous plasma with a nonuniform longitudinal electron concentration profile n(z) is considered, both waves being linearly polarized along the transverse x-axis. The system of two equations for the two electric fields with amplitudes mildly varying along the longitudinal z-axis are formulated by taking into account perturbations of the electron concentration caused by the two waves in the difference-frequency mode. This system of equations is solved by the perturbation method in the zeroth-order approximation of geometrical optics, assuming that wave beam is a Gaussian one. On the basis of the solution is then evaluated the change of energy density at each of the two frequencies as the waves mix while propagating, as the energy of the upper-frequency decreases and the energy of the lower-frequency wave increases along the path. An integral expression is obtained for the change of energy density as a function of the longitudinal coordinate $\delta W_{1,2}(z)$, assuming that both the scale of diffractional wave beam divergence and the scale of electron concentration changes are smaller than the scale of nonlinear wave mixing. A constant external magnetic field oriented at some angle θ to the z-axis in the z0y plane is then superposed and its effect shown to be to widen the

interaction space where nonlinear mixing of the two waves takes place. The results of this theoretical analysis are applied to a plasma beat-wave accelerator, for an evaluation of the results of experiments involving generation of plasma waves by means of lasers. Numerical estimates based on the data indicate that the region where plasma waves will be generated and then mix can much more effectively widened by pumping with Nd-lasers than by pumping with a two-frequency CO_2 laser, especially with use of aspherical optics. Figures 4; references 10.

Nonlinear Relaxation of Weibull Instability in Collisional Plasma

927J0124B Moscow FIZIKA PLAZMY in Russian Vol 17 No 11, Nov 91 (manuscript received 29 Dec 90) pp 1325-1331

[Article by V. Yu. Bychenkov, V. N. Novikov, V. P. Silin, and V. T. Tikhonchuk, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences; UDC 533.951]

[Abstract] The authors' model of turbulent anisotropic electron hydrodynamics describing self-consistent vortex structures in a collisionless electronic plasma (FIZIKA PLAZMY Vol 15, 1989; TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA Vol 82, 1990; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI Vol 98, 1990) is based on Maxwell equations and on replacement of the one-dimensional Vlasov equation with simpler one-dimensional equations of the ten-moments approximation of the electron distribution function in terms of the zeroth moment of electron concentration N (in the approximation of constant electron concentration and zero displacement current), the first moments of mean-velocity vector U (in the approximation of a zero potential component), and the second moments of stress tensor P. This model is now extended to a collisional electron plasma with energy dissipation due to magnetic viscosity, relaxation of pressure anisotropy, and Joule-effect heating by eddy currents taken into account. When $u = \text{curl } Bc/4\pi en$, then the entire system of those equations reduces to a system of two equations for a quasi-static magnetic field and components of the stress tensor. These equations, simplified and reduced to a dimensionless form, have been solved numerically for an analysis of nonlinear plasma relaxation under an anisotropic pressure and a Weibull instability in system of space coordinates normalized to the spatial scale of such a hydrodynamic instability. On the basis of this numerical analysis has been evaluated the dependence of its inverse characteristic increment γ on the wave number k, also the evolution of such an instability attended by a periodic space distribution of pressure which subsequently degenerates into uniform distribution while the initially applied magnetic with a monoperiodic space distribution decays and finally vanishes so that the plasma becomes ultimately isotropic. Figures 4; references 8.

Determination of Fractal Characteristics of Boundary-Layer Turbulence in TF-1 Tokamak

927J0124C Moscow FIZIKA PLAZMY in Russian Vol 17 No 11, Nov 91 (manuscript received 11 Mar 91) pp 1332-1340

[Article by V. P. Budayev and R. S. Ivanov, Institute of High Temperatures, USSR Academy of Sciences; UDC 621.039:531.19]

[Abstract] Turbulence of the boundary layer in the TF-1 tokamak is analyzed for the space distribution of its fractal characteristics, on the basis of measurements made in the TV-1 model of this tokamak (R = 22.5 cm, r = 4.1 cm, strength of toroidal magnetic field B_{z_p} = 7-15 kA, electron concentration n = (2-3) x 10^{13} cm_{-3}, initial electron temperature $T_e(0) \approx$ 200-250 eV) with four arrays of multielectrode Langmuir probes. Most data refer to a plasma current of 7 kA and a toroidal magnetic field of B_z = 1.3 T, with 3.6-3.7 stability margin at the boundary of the plasma filament. Mathematical analysis of the fluctuation signals is based on the premise of a strange attractor which always has a zero volume in its state space but can have a nonzero volume in a space of smaller dimensionality. With N(ε) denoting the smallest number of cubes which will cover the attractor completely, the fractal dimensionality d is defined as the limit $d = \lim_{\varepsilon \to 0}[\log N(\varepsilon)]/[\log(1/\varepsilon)]$. The correlation dimensionality D is defined first in probabilistic terms as the limit $D = \lim_{r(d) \to 0} [\log \Sigma_{i=0}^{N(r)} P_i^2]/[\log r(d)]$ (N_i- number of points in i-th cell of the phase space, i = 1,2,...,$N(r_d)$, P_i- probability of a point of the attractor being one of those points in the i-th cell) and then in terms of the correlation integral $C(r_d$ as the limit $D = \lim_{d \to 0}$ [log $C(r_d)$/[log r_d]. Four theoretical models have been tested on the data for a determination of the fractal dimensionality of that turbulence: 1) Henon map (a = 1.4, b = 0.3, 15000 iterations of $x_{n+1} = y_n + 1 - ax_n^2$ and $y_1 = bx_n$) yielding a dimensionality d = 1.26, 2) logistic mapping (a = 3.5699456, $x_{n+1} = ax_n(1-x_n)$ yielding a dimensionality d = 0.500+/-0.005, 3) sine wave yielding a dimensionality d = 1, 4) Gaussian random series yielding a dimensionality $d = \infty$. With the correlation integral appropriately generalized, these tests have also yielded corresponding estimates of the Kolmogorov entropy: a $K_2 > 0$ lower bound of these estimates indicating a substantial chaos. A subsequent computer-aided analysis of signals from probes located near the tokamak wall has confirmed the existence of a strange attractor in the turbulent boundary layer with almost equal fractal dimensionalities of electron concentration and electric field intensity fluctuations, their dimensionalities varying widely in a poloidal plane from a minimum $d \approx$ 4-5 at both inner $\theta = 0$ and outer $\theta = 180°$ peripheries of the discharge to $d > 10$ in both upper and lower tokamak zones. The results of this experiment agree with the results of measurements made in TOSCA and TFTR tokamaks. The authors thank A.V. Nedospasov for interest, V.N. Sychev for debugging the computer codes, and the operating staff at the TF-1 facility for assistance. Figures 4; tables 2; references 20.

Band Edge Magnetoplasmons (KMP) Under Fractional Quantum Hall Effect (KEKh)

927J0223C Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 11, Nov 91 pp 3431-3433

[Article by K. D. Chaltykyan, Theoretical Physics Institute imeni L. D. Landau, Chernogolovka, Moscow oblast]

[Abstract] The issue of band edge magnetoplasmons in a two-dimensional semibounded electron gas under the integral quantum Hall effect is addressed and an attempt is made to derive an equation of low-frequency band edge electron density fluctuations within a frequency range characterized by the singular behavior of dissipative conduction as a function of frequency under the fractional quantum Hall effect conditions. To this end, the concept of the magnetoplasmon localization length is introduced as a function of the dielectric permittivity of the ambient medium. It is shown that for a fractional population, conductivity greatly depends on frequency near the Δ_0 point where Δ_0 is the roton minimum value. A formula for calculating conductivity using the memory function formalism is proposed and it is noted that the Δ_0 variation must be taken into account for the purpose of self-consistency. The findings demonstrates that in the case of a fractional quantum hall effect, there is a region in the band edge magnetoplasmon spectrum where the frequency is roughly constant while the *Q*-factor is considerably lower than in the case of an integral population. The author is grateful to V.L. Pokrovskiy for helping to formulate the problem and S.M. Apenko for stimulating discussions. References 5: 1 Russian, 4 Western.

Onset of Self-Oscillatory Processes During Injection of Liquid into Plasma Jet

927J0167B Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 61 No 4, Oct 91 (manuscript received 16 Jan 91) pp 650-655

[Article by A.N. Golovanov, Tomsk State University imeni V.V. Kuybyshev; UDC 533.6.011.6]

[Abstract] Cooling of a blunt solid body in an oncoming hot stream by injection of a counterflowing liquid is analyzed, a liquid being a more economical and efficient coolant than a gas because of the large amount of heat it absorbs for evaporation. Considering that phase transition at the surface of a solid body may destabilize the heat transfer process by causing the coolant flow rate to fluctuate, this problem was studied in a model experiment. The experiment was performed with an EDP-104A/50 electric-arc plasmatron which generated an air plasma. The plasma formed a jet as it was passing through a 14 mm wide round exit hole in the anode. The test models were cones made of Cr19Ni9Ti stainless steel having each a hemispherical head and a 20 mm wide flat base, a coaxial cylindrical cavity inside each having a hemispherical head concentric with the cone head and a flat base parallel to the cone base. The plasma jet thus attacked a round head wall of uniform d = 1 mm thickness before flowing past a conical skirt. The distance from the stagnation point on the cone tip surface to the center of the exit hole in the anode was varied over the 2.5-7.5 cm range. Cooling water was fed into the cylindrical cavity through a duct in the flat base and injected into the plasma jet, countering it, through a 1 mm wide circular hole in the center of that hemispherical wall segment. The process was tracked on oscillograms. The water injection rate was monitored with PC, PM, and GF rotameters. The wall temperature at 60°, 30°, and 5° from the stagnation point was monitored with a high-speed photoelectric pyrometer measuring the brightness temperature. The temperature inside the cavity at two points on the axis of symmetry 10 mm and 20 mm behind the spherical wall segment (stagnation point) was monitored with two Cu-Alumel thermocouples. The data have been processed in terms of a self-oscillatory convective cooling process, the dependence of both the wall temperature and the heating time till onset of film boiling on the water rate and the thermal flux at the wall having been approximated with the applicable expression for the Strouhal number as a function of the Reynolds number and evaluated on this basis. In this dimensionless expression the wall temperature was referred to a 1600 K maximum temperature and the heating time was referred to the characteristic heating time $t_h = d^2/a$ (d- wall thickness, a-thermal diffusivity of wall material). The results of these calculations are fairly consistent with readings on the oscillograms. Figures 4; references 7.

Electron-Phonon Mechanism of Superconductivity in Hubbard Model

927J0241B Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 91 No 3, Jun 92 (manuscript received 22 Jul 91) pp 463-473

[Article by Chang Min Tien, Moscow State University]

[Abstract] The electron-phonon mechanism of superconductive pairing in the Hubbard model is considered for evaluating the dependence of both critical superconducting transition and Peierls transition temperatures, also of the isotope effect, on the particle concentration. So electron-phonon interaction is included in the Hamiltonian of this model, which also includes uninodal Coulomb repulsion. Location of the Fermi is determined from the equation for the chemical potential μ and thus also the particle concentration n. Following replacement of Fermi operators at N lattice nodes with Hubbard operators and using the Nambu representation of operators in Green's two-time function, there is obtained a system of four equations: two for the electron Green's function G and the phonon Green's function D in the Hubbard-I approximation, two for the mass operator Σ and the polarization operator Π in Dyson's equation. These four equations together with the equation for the chemical potential form a closed system. With the phonon Green's function in zeroth-order approximation and the electron Green's function in the weak-link approximation, they yield a linearized system of equations for the superconductivity gap Δ_i (i= 1,2,3). This system is reduced to one of linear algebraic equations. From the condition for this system having a nontrivial solution (zero determinant of coefficients a_{ij}) are obtained both critical temperatures. Simultaneous numerical solution of the $\det||a_{ij}|| = 0$ equation and the equation for the chemical potential (particle concentration) in the normal state are has yielded a symmetric dependence of the critical superconducting transition temperature on the particle concentration $T_c(n) = T_c(2-n)$ so that only the lower energy band with $n \leq 1$ needs to be considered. This critical temperature is found to be higher in the in the limiting case of infinitely strong uninodal Coulomb repulsion than for a plain Fermi system without Coulomb correlation and, as always, higher than the critical Peierls transition temperature. Both critical transition temperatures in the case of an infinitely strong Coulomb repulsion are found to be maximum when the particle concentration is $n \approx 2/3$ and thus close to the corresponding Van Hove singularity in the quasiparticle spectrum, this singularity evidently shifting when Coulomb correlation is included. The subsequently calculated isotope effect in this case has a local minimum when the critical superconducting transition temperature is maximum and thus also close to that singularity. The author thanks N.M. Plakida for fruitful discussions. Figures 4; references 17.

Superconductivity Model With Three Overlapping Energy Bands and Phononless Mechanism

927J0241C Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 91 No 3, Jun 92 (manuscript received 24 Dec 91) pp 483-499

[Article by M. G. Kalalb, F. G. Kochorbe, and M. E. Palistrant, Institute of Applied Physics at Academy of Sciences of Moldovan Republic]

[Abstract] The multiband model with three overlapping energy bands on the Fermi surface is considered for an explanation of hypothetically phononless electron superconductivity in high-T_c materials. The state of such a material is described by a system of equations for the energy gap Δ_i (i= 1,2,3) and a system of equations relating the electron concentration n= 1,2,3 and the chemical potential μ, assuming that only interband electron-electron interaction V_{ij} and no intraband electron-electron interaction action (V_{ii}= 0) takes place. From these equations in the quasi-2-dimensional approximation are derived expressions for calculating the temperature-dependent critical magnetic field H and the specific heat at temperatures $T/\Delta_i << 1$, the temperature-dependent order parameters Δ_n (n= 1,2,3) at temperature T= 0, the critical superconducting transition temperature T_c, then the order parameters and the jump of specific heat $c_S - c_N$ (S- superconducting state, N- normal state) at that critical temperature. Numerical calculations for various electron concentrations in the j= 1,2,3 valleys of the Fermi surfaces and various dispersions of electron energy in the i= 1,2,3 bands (ranging from 0 to 0.35 eV, thus energy dispersions from smaller to larger than the chemical potential $\eta = -\mu$) confirm the hypothesis. The results agree qualitatively with experimental data on $YBa_2Cu_3O_{7-d}$ compounds, which indicate a step-like dependence of T_c on the oxygen deficiency. Experimental data on $La_{2-x}Sr_xCuO_4$ compounds indicate a jump $c_S/T - c_N/T > 0$ as $T \rightarrow 0$ and its dependence on the impurity concentration, which is likely in the gapless ground state of a superconductor material with a higher density of electronic states than in its normal state. Figures 5; references 34.

Nonsuperconducting Oxide $TlBa_2LaCu_2O_7$ With 1212 Structure

927J0230A Moscow KRISTALLOGRAFIYA in Russian Vol 37 No 3, May-Jun 92 (manuscript received 20 Sep 91) pp 571-575

[Article by R. A. Tamazyan, V. N. Molchanov, V. I. Simonov, N. N. Kolesnikov, M. P. Kulakov, V. Ye. Korotkov and R. P. Shibayeva, Crystallography Institute, Russian Academy of Sciences; Solid State Physics Institute, Russian Academy of Sciences; UDC 548.736]

[Abstract] The crystal structure of $TlBa_2LaCu_2O_7$ was determined and made more precise. It is shown that by means of doping Tl cuprates with cations of a higher valency it is possible to reduce the degree of copper

oxidation and depending on the degree of doping, change the properties of these compounds. With doping by cations of a lesser valency the degree of copper oxidation increases. In the described research monocrystals of the phase 1212 are obtained in which Ca^{2+} cations are replaced by La^{3+} cations. This did not result in a sharp change in the structure and the general character of ion packing in the crystal was conserved. The synthesis of the studied monocrystals is described and the results of X-ray structural analysis are presented. Their superconducting properties and structure are described. A comparison of the structural characteristics of the nonsuperconducting phase and the phase $TlBa_2CaCu_2O_7$, undergoing transition to a superconducting state at 80 K, is given. The principal differences between these two crystals are summarized in a table. Figure 1; references 21: 2 Russian, 19 Western.

Anisotropy of Upper Critical Field in Hexagonal Exotic Superconductor

927J0216B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 5, May 92 (manuscript received 3 Jan 92) pp 1689-1697

[Article by Yu. S. Barash and A. V. Galaktinov, Institute of Physics imeni P.N. Lebedev at Russian Academy of Sciences]

[Abstract] An approximate analytical expression for the upper critical field H_{c2} in an exotic superconductor such as UPt_3 with a hexagonal crystal lattice and strong spin-orbit interaction is derived on the basis of the Ginzburg-Landau free energy, considering that the order parameter for such a superconductor has two complex components. The expression for this free energy has been reduced to one of second-order precision with respect to invariants and the sum of its gradient terms is positive-definite. The expression for the upper critical field is a general one, valid for any field orientation. It shows that the angular distribution of H_{c2} does not contain more extrema and its anisotropy thus is not more nonmonotonic than in an ordinary superconductor. This is explained by an only very slight breaking of particle-hole symmetry in the superconductor, not sufficiently strong to give rise to an additional maximum. Figures 4; references 13.

Possible Mechanism of High-Temperature Superconductivity

927JO204D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 4 Apr 92 (manuscript received 19 Jul 91) pp 1246-1258

[Article by P. I. Arseyev; Physics Institute imeni P. N. Lebedev, Russian Academy of Sciences]

[Abstract] A new model is proposed for explaining the mechanism leading to the unusually strong pairing of electrons (holes) in Cu-O conducting layers in high-temperature superconductors (of the $YBa_2Cu_3O_7$ type). Until now, despite many efforts, there has been no satisfactory explanation of the mechanism of this phenomenon. The new model takes into account the exchange interaction of electrons at the x^2-y^2 and z^2 levels of copper. The properties of two-dimensional superconductivity in an individual layer are discussed on the assumption that in general the interaction between layers stabilizes superconductivity at the macroscopic level. It was found that forming virtual bound states of conductance electrons with electrons at the z^2 level play the role of local two-particle states. The interaction of such bound states with a total energy close to E_F with conductance electrons leads to high T_s values and arbitrary $2\Delta/T_s$ ratios dependent on the energy parameters of the problem. A whole series of experimental results relating to high-temperature superconductors can be explained within the framework of this theory. Figures 4; references 12: 2 Russian, 10 Western.

Relaxation of Exciton Excitations in High-T_c Superconductors

927J0159A Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 18 No 2, Feb 92 (manuscript received 7 May 91) pp 135-139

[Article by Yu. B. Gaydidey and V. M. Loktev, Institute of Theoretical Physics, Ukrainian Academy of Sciences, Kiev; UDC538.945]

[Abstract] The hypothesis that scattering of excitons by free charge carriers is very likely the principal mechanism of relaxation of exciton excitations in these high-T_c superconductors, the hypothesis being based on an analysis of the temperature dependence of light absorption by such materials, is verified by calculation of the relaxation constants pertaining to excitons. Considering that the energy levels of d-shell states split in the Cu^{2+} ion by a tetragonal crystals field lie 1-2 eV above the x^2-y^2 ground state and that only that electron-hole pairs are excited into a bound state by an incident electromagnetic wave, analytical expressions are obtained for: 1) the exciton excitation Hamiltonian $H_{exc} = \Sigma_k \varepsilon_{exc}(k)B^+(k)B(k)$ ($k = 1,2,...$, ε_{exc} and $B^+(k)$ respectively the energy and the generation operator of an exciton with wave vector k); 2) the carrier excitation Hamiltonian, the generation-annihilation operators $p^+(k,\sigma)$,$p(k,\sigma)$ of a free carrier with wave vector k and spin σ in the normal phase and the operators of an elementary excitation in the superconducting phase being related through the Bogolyubov transform); 3) the exciton-carrier interaction Hamiltonian, neutrality of excitons preventing the $V_{exc\text{-}car}$ (k_1, k_2; k_3, k_4 as a function of the former) interaction parameter from being larger than the carrier generation operator $p^+(k,\sigma)$. The intensity and the coefficient of light absorption coefficient by excitons in a superconductor are then calculated by the method of Green's functions in the perturbation theory. The authors thank I.Ya. Fugol for sharing not yet published results of her group's study of light transmission by

YBa_2Cu_{37-d} ($d \approx 0.3$) single-crystal films, and also A.S. Davydov, M.A. Ivanov, and A.A. Serikov for helpful comments. References 13.

Bipolaron Large-Radius States and Problem of High-T_c Superconductivity. Review

927J0220B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 37 No 1, Jan 92 pp 76-94

[Article by V. L. Vinetskiy (deceased), N. I. Kashirina, E. A. Pashitskiy, Physics Institute at the Ukrainian Academy of Sciences, Kiev, and Semiconductors Institute at the Ukrainian Academy of Sciences, Kiev; UDC 537.312.62]

[Abstract] The existence of coupled two-electron and bipolaron states in high-T_c superconductors (VTSP) and their manifestations are discussed and numerous published sources, both foreign and local, dealing with this subject are reviewed in detail. The issues of bipolaron states, the superconductivity of metal-ammonia solutions, and the bipolaron mechanism of superconductivity and more specifically, an almost-perfect bipolaron gas, an imperfect bipolaron Bose-system, Cooper pairs in ionic crystals, and bipolarons and superconductivity in anisotropic quasi-two-dimensional and quasi-unidimensional crystals are investigated. Systems with an anisotropy of the effective charge carrier mass and dielectric permittivity are examined and the conclusion is drawn that, generally speaking, the question of the physical origin and mechanism of high-T_c superconductivity in cuprate metal oxide compounds (MOS) still remains open. It is speculated that high-T_c superconductivity may be due to the bipolaron superfluidity and that the high-T_c superconductivity in laminar cuprate MOS's may be caused by the formation of a condensate of highly coupled Cooper pairs with a small radius or highly coupled bipolarons with a large radius; the difference between these two mechanisms is largely erased in the case of 2*D*-systems. Figures 1; references 66: 42 Russian, 24 Western.

Theory of Andreyev States in Superconducting Junction With Ferromagnetic Tunnel Barrier $S_1I(F)S_2$ During Passage of Josephson Current

927J0212C St Petersburg FIZIKA TVERDOGO TELA in Russian Vol 34 No 1, Jan 92 (manuscript received 25 Jul 91) pp 183-189

[Article by S. V. Kuplevakhskiy and I. I. Falko, Kharkov State University imeni A. M. Gorkiy; UDC 538.945]

[Abstract] The theory of a bound quasiparticle state near a tunnel barrier in symmetric superconducting junctions (M.J. De Weert, G.B. Arnold; PHYSICS REVIEW LETTERS Vol 55 No 14, 1985) and specifically near a ferromagnetic tunnel barrier I(F) (ferromagnetic dielectric) in such a junction (S.V. Kuplevakhskiy, I.I. Falko; FIZIKA NIZKIKH TEMPERATUR Vol 10 No 7, 1984) is modified so as to take into account passage of a Josephson current and then extended to asymmetric junctions with such a tunnel barrier. First is considered a symmetric SI(F)S junction with a symmetric potential well (Ginzburg-Landau valley). The effective depth of this potential well is determined from the solution $|\Delta_{G-L}|(x)$ to the Ginzburg-Landau equation for the pairing potential as a function of the longitudinal x-coordinate and from the solution to the linear integral equation of the microscopic (Bardeen-Cooper-Schrieffer) theory, assuming perfectly uniform depth in (yz) planes. Next is considered a symmetric SI(F)S junction carrying a current, its bound state being described by the system of Bogolyubov-DeGennes equations. The energy of this state is then calculated accordingly for such a junction with a nonexchange potential V and an exchange potential J of the tunnel barrier. Finally is considered an asymmetric $S_1I(F)S_2$ junction carrying a current, specifically one with a nonexchange potential V of the tunnel barrier much higher than both its nonexchange potential J and the Fermi velocity v_0. The bound state energy in such a junction is calculated only for an extremely asymmetric one with a gap ratio $R = \Delta_1/\Delta_2 << 1$ and the probability of tunneling $T(1) << 1$, inasmuch as an explicit expression for the energy covering the entire $0 < R < 1$ range is difficult to obtain analytically. The condition for existence of a bound state in such an asymmetric junction is shown to reduce to $\cos\psi < R$ when $J = 0$ (ψ-coherent phase difference between the respective to order parameters, $|\psi \leq 2\pi$). References 11.

Effect of Mechanical Stress on the Properties of Bismuth and Yttrium High-Temperature Superconducting Ceramics

927J0238B St. Petersburg FIZIKA TVERDOGO TELA in Russian Vol 33 No 12, Dec 91 (manuscript received 12 Jul 91) pp 3595-3597

[Article by T. S. Orlova, L. K. Markov, B. I. Sirnov, V. V. Shpeyzman, and Yu. P. Stepanov, A. F. Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg; UDC 537.312.62]

[Abstract] The percolation-like character of conductivity in high-temperature superconductors has been established. Now there is great interest in the study of weak bonds, which determine the critical current and some other characteristics of these materials. One of the factors affecting weak bonds is mechanical stress. Hydrostatic pressure in compression along one axis affects the volt-ampere characteristics of yttrium high-temperature superconducting ceramics, leading to an increase in the critical current and a shift in the volt-ampere characteristics toward higher currents. In this article this effect is studied for $YBa_2Cu_3O_{7-x}$ and $Bi_{1.85}Pb_{0.35}Sr_{1.9}Ca_{2.1}Cu_{3.1}O_y$ in their initial form and alloyed with silver. The preparation of the ceramics is described. The temperature dependence of electric resistance is determined at 77-300 K, and the volt-ampere characteristic is determined at 77 K. Additions of silver

caused a decrease in the critical current and the deformation effect. However, the decrease in the critical current is not a necessary condition for a decrease in the deformation effect. The reasons why silver may decrease the effect of a load on the volt-ampere characteristic are discussed. Figures 2; references 7: 6 Russian, 1 Western.

Features of the Resistive Characteristics of a Stabilized Superconductor

927J0239B St. Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 12, Dec 91 (manuscript received 7 Feb 91) pp 65-70

[Article by A. N. Kopchikov, Stabilizatsiya Provisional Scientific and Technical Collective, Moscow]

[Abstract] In an examination of issues associated with the distribution of current in a cryostatically stabilized single-core rigid superconductor, an equation was deduced and solved for the case where a superconductor in a noticeable electric field has a linear volt-ampere characteristic with a negative derivative. It is found that in a longitudinal distribution of voltage in a composite, in addition to the linear term there is also a term which depends sinusoidally on the length of the working region. In experimental verification of these equations, it was found that the determination of the length must be very accurate, and the properties of the substrate and superconductor must be very homogeneous over that length. The experiment showed in some working regions that the resistance of the stabilizing substrate in a magnetic field $\mu_0 H_e$ = 9.00 Tesla differed by about 0.5 percent. In a relatively strong electric field in a composite, in the linear portion of the volt-ampere characteristic there is a sinusoidal deviation in voltage distribution when the resistance of the substrate is numerically corrected to homogeneous. Figures 4; references 10: 8 Russian, 2 Western.

On Nonphonon PdH_x Superconductivity

927J0223B Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 11, Nov 91 pp 3183-3191

[Article by R. O. Zaytsev, Atomic Energy Institute imeni I.V. Kurchatov, Moscow; UDC 538.945]

[Abstract] The existence of inverse isotropic effect in PdH and PdD at T_c=8K and 10K, respectively, and the hypothesis of the nonphonon Cooper pairing origin in hydrides prompted an investigation of the purely electronic mechanism of superconductivity which is responsible for high-T_c superconductivity of cuprates and leads to a rather sharp dependence of T_c on the concentration x. The equations of state are derived, the superconductivity condition is formulated, and the phase diagrams of the anion and proton states are plotted. The electron structure of the PdH compound is examined allowing for Hubbard's electron-electron repulsion and the domain of superconducting state at T=0 and at a variable degree of underpopulation of the $4d^{10}$ and $1s^2$ atomic shells in Pd and H^- is determined. It is noted that the electronic mechanism is characterized by a sharp dependence of the scattering amplitude sign calculated on the Fermi surface on its position inside Brillouin's zone which is manifested by the presence of several nonoverlapping superconducting areas on the phase plane. The author is grateful to Yu.V. Mikhaylov for helping with numerical calculations. Figures 1; references 16: 6 Russian, 10 Western.

Nonlinear Penetration Dynamics of Magnetic Flux in Superconductor

927J0146A Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1247-1249

[Article by I. L. Maksimov, Nizhnegorodskiy State University]

[Abstract] The behavior of a magnetic flux penetrating a superconductor with a large Ginzburg-Landau parameter is briefly analyzed on the basis of the single equation of electric field E(r,t) perturbations $[E\Delta(dE/dt) - (dE/dt)\Delta E] + 4\pi\sigma[(dE/dt)^2 - Ed^2E/dt^2]/c^2 + aE^2\Delta E/v = 0$. This equation, which can very well describe nonlinear dynamics of thermomagnetic perturbations of arbitrary magnitude in type-II superconductors with a large Ginzburg-Landau parameter, has been derived from the equation of heat conduction by eliminating the temperature variable and using the "equation of state" $\delta j = -aT + \sigma\delta E$ (δj-current perturbation, δT-temperature perturbation, δE-electromagnetic perturbation). The complete spectrum of possible solutions to that equation has not yet been determined, but can include thermomagnetic shock waves and solitons. The possibility of an explosive mode of superconductor penetration by a magnetic flux and the feasibility of its experimental verification are also considered, inasmuch as an analysis of the confluence of kinks readily demonstrates that interaction of shock waves is responsible for explosive dynamics of the critical state of superconductor materials. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. References 8.

Phonons and Mechanism of High-Temperature Superconductivity

927J0146B Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1314-1319

[Article by M. F. Limonov, Yu. F. Markov, A. G. Panfilov, and B. S. Razbirin, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences, Sankt Peterburg]

[Abstract] On the basis of available experimental data pertaining to high-T_c superconductor compounds, relations which govern the vibration spectra of such compounds are established. Data on the spectral density of

vibrational states of electron-phonon interaction were obtained by neutron diffractometry and reveal an increase of their spectral density within the intermediate optical frequency range (ν = 300-500 cm^{-1}) upon transition of such a material from normal state ($YBa_2Cu_3O_6$) to superconducting state ($YBa_2Cu_3O_7$). Data on Raman scattering of light, namely polarized Raman scattering spectra, reveal that elevation of the critical temperature T_c is related to a rise of optical frequencies. These data, supplemented with experimental data on tunneling, indicate that the mechanism of high-temperature superconductivity includes a phonon factor. This is further demonstrated by an analysis of actual vibrations within the ν_c band and of resonance phonons in metal-oxide superconductor materials. Optimization of both phonon and electronic subsytems for the purpose of raising the critical temperature has already been shown to be feasible and especially so in materials with a perovskitic structure, their structure being optimizable independently with respect to phonon characteristics and electronic characteristics. The highest critical temperature has also been shown, however, to be attainable only with an optimized electronic subsystem, its optimization involving a change of the charge carrier concentration by either nonisovalent substitution or nonisomorphic change of composition. New high-T_c superconductor materials should nevertheless be sought among compounds which have a wide phonon spectrum and allow varying the concentration of free charge carriers over a wide range. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. Figures 2; references 24.

Discovery of Non-Josephsonian Nonlinear Response of Point Junction Formed by High-T_c and Normal Metal to External Microwave Radiation

927J0146C Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1355-1358

[Article by V. M. Dmitriyev. A. L. Solovyev, A. I. Dmitrenko, and A. B. Agafonov, Institute of Low-Temperature Physics, Ukrainian Academy of Sciences, Kharkov]

[Abstract] An experimental study of S-c-N point junctions formed by a crystallite of $Tl_2Ba_2CaCu_2O_x$ ceramic and an Nb pivot was made for a study of their response to external 12 GHz microwave radiation at temperatures covering the 4.2-300 K range. The critical superconducting transition temperature for the ceramic material was very close to 100 K. The current-voltage characteristics of these junctions were distinctly metal-like with a large excess current at high voltages and with a minimum differential resistance $R_d = dV/dI$ at the zero voltage crossover $V = 0$. Two kinds of such junctions were forming: 1) junctions with a damped-oscillatory nonmonotonic dependence of the excess current at high bias voltages $V >> \Delta$ on the radiation power within the 100-50 K temperature range, this nonlinear relation not being associated with the Josephson effect; 2) junctions with a parabolic dependence of the excess current on the radiation power within the 100-50 K temperature range, the excess current climbing to a maximum and then falling to zero as the radiation power increases to -30 dB and then to 0 dB. An analysis of the results indicates excess-current stimulation by the Eliashberg mechanism (external electromagnetic radiation shifting the "center of gravity" of the electron energy distribution function $n(\varepsilon)$ to higher energy levels, provided the current density distribution is uniform and the frequency of incident radiation is higher than the inverse of the relaxation time for inelastic collisions with phonons) when the power of incident microwave radiation is low and by the Aslamazov-Larkin mechanism (upward diffusion of the energy of electrons within the junction region owing to "jitter" of the potential well) when the power of incident microwave radiation is high. These modes of nonlinear excess-current stimulation by radiation can thus be explained as due to an intricate quasiparticle spectrum and intricate transport properties of new superconductor materials such as Tl-Ba-Ca-Cu-O compounds. The authors thank B.I. Belevtsev, Yu.Ya. Divin, Ye.V. Khristenko, and G.Ye. Churilov for helpful discussions. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. Figures 3; references 11.

Suppression of Superconductivity by Optical Radiation and "Memory" Effect in $YBa_2Cu_3O_{7-d}$ Films

927J0146D Kharkov FIZIKA VYSSHIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1366-1369

[Article by P. P. Vysheslavtsev and Yu. N. Nozdrin, Institute of Applied Physics, USSR Academy of Sciences, Nizhniy Novgorod]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-d}$ superconductor films was made concerning their excessively resistive response to external laser radiation. The films were deposited on Zr_2O substrates and on $SrTiO_3$ substrates by a laser- beam sputtering process which ensured formation of a modular structure with the crystallographic c-axis normal to the plane of a film. The middle segments of these films were narrowed down into 3-8 mm long 50-500 μm wide bridges. The critical superconducting transition temperature for these films was T_c = 84-85 K and the transition range did not exceed 2-3 K, the critical current density for the bridges at 77 K being 2 kA/mm^2 or higher. Electrical resistance measurements were made by the current-voltage method with a constant transport current much lower than the critical one, while a spot about 1 mm in diameter between the voltmeter contacts was being treated by a Nd-laser with 1.06 μm radiation in pulses of about 30 ns duration delivering a beam power of about 1.5 kW/cm^2. The waveform of voltage response signals appearing across the voltmeter indicated that two different relaxation

processes were taking place in the response to irradiation: 1) slow relaxation with a characteristic time much longer than 10 μs, evidently associated with thermal heating of the superconductor lattice and its duration determined by the rate of heat dissipation; 2) fast relaxation with a characteristic time not longer than 10 ns, evidently associated with an athermally induced nonequilibrium in the system. The time delay from the beginning of an incident radiation pulse to the appearance of a response signal at temperatures below T_c indicates, moreover, the existence of a radiation intensity threshold with respect to emergence of an excessively resistive state. An analysis of the athermal response to irradiation reveals a "memory" effect in these Y-Ba-Cu-O bridges, the amplitude of a response signal being proportional not to the amplitude of the incident radiation pulse but to the amplitude of the preceding one. Further analysis of the experimental data reveals another characteristic of the response of Y-Ba-Cu-O bridges to irradiation, only the response signal from those with a temperature-dependent electrical resistance lower than some critical resistance R_c including the athermal component and the response signals from those with an electrical resistance higher than R_c containing only the thermal component. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. Figures 3; references 2.

Memory Effect in High-T_c Films During Quenching of Superconductivity by Optical Radiation

927J0146E Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1369-1372

[Article by A. V. Okomelkov, Institute of Applied Physics, Nizhniy Novgorod]

[Abstract] The memory effect in $YBa_2Cu_3O_{7-d}$ films attending suppression of their superconductivity by laser radiation in the absence of an external magnetic field, observed in the course of an experimental study made at the Institute of Applied Physics and characterized by a long retention time dependent on the conditions of the experiment, is hypothetically associated with circulation of supercurrents and formation of magnetic Abrikosov vortices. Motion of these vortices would then be responsible for the resistive response of high-T_c films to irradiation by a laser. A model of the memory effect is proposed on this premise which takes into account that the structure of these films consists of "strong" superconductivity and "weak" superconductivity regions. Considering that the magnetic field of the transport current in such experiments is not stronger than the first critical magnetic field H_{c1} for Y-Ba-Cu-O crystallites, in the absence of incident radiation this magnetic field penetrates only the regions with weak links. Subsequent irradiation suppresses the superconductivity in these regions so that the boundaries between regions with weak links and regions with strong links shift toward the "strong" superconductivity regions, as do the magnetic vortices located along those boundaries. During the pause following an incident radiation pulse, while superconductivity is being restored, the quite "deep" pinning potential well in Y-Ba-Cu-O films traps magnetic vortices which move behind those boundaries so that they remain "frozen in" while those boundaries relax toward their original positions in space. As those boundaries thus move back, the magnetic vortices become again trapped by the pinning centers. According to this model, the number of magnetic vortices is proportional to the displacement of the boundaries they follow and thus to the intensity of incident radiation. The next radiation pulse detaches the trapped magnetic vortices from the pinning center by the photoexcitation mechanism, whereupon they interact with the transport current and move toward one another till they collide and thus annihilate one another. A resistive response signal is then generated, its magnitude being proportional to the number of "frozen in" magnetic vortices and thus to the amplitude of the preceding radiation pulse. Extraction of magnetic vortices from pinning centers occurs evidently according to the jump creep modification of the Anderson-Kim model. The memory retention time can be very long and is determined by the supercurrent attenuation process. The author thanks A.A. Andronov, G.M. Genkin, Yu.N. Nozdrin, I.D. Tokman, and P.P. Vysheslaventsev for discussing the theoretical model. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. Figures 2; references 5.

Pinning of Magnetic Flux and Its Interaction With Surface Currents in Granular High-T_c Superconductors

927J0146F Kharkov FIZIKA NIZKIKH TEMPERATUR in Russian Vol 17 No 10, Oct 91 pp 1404-1407

[Article by G. V. Sotnikov and A. G. Terekidi, Institute of Atomic Energy imeni I. V. Kurchatov, Moscow]

[Abstract] An experimental study of granular $YBa_2Cu_3O_{7-d}$ ceramic in weak alternating magnetic fields was made for information about pinning of the magnetic flux. This information was obtained from the dependence of the response signal, specifically of its fundamental-frequency component and lowest two even harmonics (second and fourth) on the amplitude of such an alternating magnetic field. The ceramic material was synthesized according to the standard technology and cast into a 12 mm long cylinder 2.4 mm in diameter, on which was then wound a double-layer coil with 567 turns of 0.05 mm thick copper wire. A slowly varying static external magnetic field and a modulating magnetic field were produced by two coaxial coils of copper wire. The temperature was varied over the 78-92 K range and monitored with a carbon thermometer touching the specimen. The electric signal picked up by the receiver coil was transmitted to a PARC 5301A Lock-in analyzer. Signals from a probe with a measuring coil and a

compensating coil were analyzed, after passage through a PARC 113 amplifier and a PARC TDH-9 averager, for a determination of both intergranular and intragranular currents and subsequent evaluation of their field dependence. The external magnetic field was swept over the 18-0-(-18) Oe range at a rate of 0.001 Hz. The modulation frequency was 50 kHz for measurement of the magnetic susceptibility at the fundamental frequency, was 100 kHz for its measurement at the second-harmonic frequency, and was 200 kHz for its measurement at the fourth-harmonic frequency. For measurement at the fourth-harmonic frequency a special oscillator was constructed generating a reference signal in synchronism with the fundamental-frequency component. The critical current was determined on the basis of measurements by the contactless modulation method. A theoretical analysis of the results indicates that the dependence of the critical current for these Y-Ba-Cu-O ceramic on the intensity of the external magnetic field follows an inverse-square law rather than Kim's inverse law when the modulation amplitude is smaller than the instantaneous magnitude of the quasi-static magnetic field and the magnetic flux then penetrates the material in a linear mode (depth of penetration approximately equal to amplitude of modulating magnetic field divided by critical current density). The field dependence of the second-harmonic component was found to be nearly linear within the 5-0-(-5) Oe range only, then to follow Kim's classical law above 7 Oe and below -7 Oe. The presence of even harmonics in the response signal could be due to the field dependence of the critical current, which leads to a nonequivalence of magnetic flux penetration during the two cycle half-periods of the modulating magnetic field. For an explanation of this, a surface barrier model is proposed according to which each granule carries a magnetic moment induced by the pinning effect and the resulting current unbalance. Interaction of the current within a granule and the Josephson hypervortex current gives rise to an additional pinning force but only within the superconductor surface layer. Upon superposition of a weak and therefore not significantly penetrating modulating magnetic field, this additional pinning force will act in the direction of the Lorentz force during one modulation half-period and in the opposite direction during the other modulation half-period. Inasmuch as the vector sum of both forces is the same during both half-periods, their interaction will lower and raise the critical current for the superconductor surface layer during the respective half-periods so that the response signal becomes asymmetric. Paper was presented at the Third All-Union Conference on High-Temperature Superconductivity 15-19 April 1991 in Kharkov. Figures 2; references 4.

Effect of Impurities on Thermophysical Properties of Nickel

927J0089B Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 23 Oct 90) pp 1108-1111

[Article by V. Ye. Sidorov, N. V. Vandysheva, F. A. Tyutrin, and B. A. Baum, Uralsk Polytechnic Institute; UDC 536.023:546.74]

[Abstract] An experimental study of polycrystalline nickel containing 0.004-0.044 atom. percent oxygen was made concerning the influence of this impurity on the temperature dependence of its electrical resistivity and thermal diffusivity. Specimens of electrolytic grade N-O nickel (density 8.88 g/cm^3) were purified by electron-beam remelting under vacuum, which lowered the total impurity content except oxygen down to half nominal while maintaining the oxygen content at the 0.0440 atom. percent level. Liquefied, they were then held under vacuum at a 1920 K temperature for various lengths of time ranging from 30 min to two hours so that the oxygen content decreased accordingly. Thermal diffusivity was measured by the method of plane temperature waves with electronic heating, only from 750 K to the melting point, and two-three minutes holding time at each point. The specimens for these measurements were 0.3-0.5 mm thick hollow cylinders 12 mm in diameter. Their temperature was monitored by a W-Rh (5-20) thermocouple with 0.03 mm wires. Electrical resistance was measured by the standard voltage-current method with a direct current and with time-sequential current switching, covering only the temperature range from 300 K to the melting point. The specimens for these measurements were 15-20 mm long square bars with a 2x2 mm^2 cross-section. Their temperature was monitored by a W-Rh (5-20) thermocouple with 0.1 mm wires. All measurements were made under a vacuum of 1 mPa maximum. The results indicate that an increase of the oxygen content from 0.0044 atom. percent to 0.044 atom. percent causes the electrical resistivity at 1170 K to increase by about 25 percent and the thermal diffusivity at 1170 K to decrease by about 20 percent. The temperature coefficient of electrical resistivity meanwhile also changes, but nonmonotonically with a maximum at a 0.010 atom. percent oxygen content. These trends cannot be explained by a straight shift of the Fermi energy, inasmuch as the n(E) curve characterizing the energy dependence of the density of states is quite smooth. A logical explanation would be existence of a local minimum on this curve near the Fermi level, a small shift of this minimum causing the change of thermal diffusivity and electrical resistivity. This local minimum could very well be due to microdomains with an electronic structure different than that of pure nickel forming around the interstitial oxygen atoms. The study has thus revealed an appreciable influence of oxygen on the electronic structure of nickel at high temperatures. Figures 4; tables 3; references 6.

Numerical Modeling of an Optimal Thermal Battery Based on Phase Transition

927J0187 Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 61 No 5, Nov 91 (manuscript received 17 Jan 91) pp 749-755

[Article by O. V. Dikhtiyevskiy, G. V. Konyukhov, O. G. Martynenko, and I. F. Yurevich, Academic Scientific Complex of the A. V. Lykov Institute of Heat and Mass Transfer, Academy of Sciences of the Belorussian SSR, Minsk; UDC 536.42:621.31.61]

[Abstract] This article presents a method for and the results of mathematical modeling of an optimal thermal battery based on a phase transition. It operates with periodic charging from a solar energy concentrator. The calculations were done for two types of heat carrier in laminar and turbulent flow modes. The battery is used in an energy transport system. The battery differs from others in the method of delivering the radiant flux, which enters a receiving window filled with focusing fibers which transfer the energy directly to hollow narrow lightguides with partial absorption. The battery also features dense three-dimensional packing of heat storage elements. Aggregates can be constructed from heat storage modules, greatly reducing the size and mass of the battery. Modeling was done to determine the optimal mass, hydraulic, geometric, and light absorption parameters. Figures 3; references 8: 7 Russian 1 Western.

Negligibly Distorting Action of Nematic Liquid Crystal Medium on Ordinary Wave (Theory and Experiment)

927J0216C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 5, May 92 (manuscript received 11 Dec 91) pp 1541-1549

[Article by N. B. Baranova, V. Ya. Zeldovich, I. B. Gusev, V. A. Krivoshchekov, and B. Ya. Metelitsa, Chelyabinsk State University]

[Abstract] Passage of an ordinary wave through thick nematic liquid crystals is analyzed, considering that thick nematic liquid crystals are opaque, because of intense small-scale light scattering by director fluctuations during thermodynamic equilibrium and possibly because of large-scale director nonhomogeneity. On the basis of this premise and by considering also that the refractive index of such a medium for an o-wave does not depend on the director orientation n relative to the wave vector k, it is demonstrated theoretically that passage of an o-wave through a thick nematic liquid crystal will not be accompanied by phase distortions and its waveform will thus remain almost undistorted. To prove this, corrections to the phase of an adiabatically propagating wave are calculated on the basis of Maxwell equations for monochromatic radiation in a nematic liquid crystal with a local director orientation n(r) such that $|n| = 1$. Numerical estimates based on this theory indicate the feasibility of transmitting an image through an up to 5 mm thick nematic liquid crystal by means of an o-wave, with the the possibility of a 180° phase jump. This conclusion is confirmed by the results of an experiment involving passage of light either from a slide projector or from a He-Ne-laser through a teflon cell containing a 5TsB nematic liquid crystal. The light from the projector with the image of the slide was focused on a screen or on a photographic plate. When light from the laser was sent through, its divergence was first corrected by means of a lens or a telescope. Without polarizers the liquid crystal was so opaque that no image could be seen on the screen. With a polarizer either before or behind the cell, the polarized o-wave carried the image of the slide to the screen without distortion. This behavior of an o-wave contrasts significantly with the behavior of an e-wave, the refractive index for a latter depending strongly on the director orientation relative to the wave vector. In another experiment with an He-Ne laser its collimated 2 mm wide beam first with an o-wave and then with an e-wave was sent through the crystal cell. In both cases one part of the light was diffusely scattered there at wide angles, evidently by thermodynamic fluctuations of the director orientation (molecular scattering), and one part of the light was transmitted carrying the image (57 percent, 37 percent, and 9 percent of incident o-wave light by a 0.6 mm, 1 mm, and 3 mm thick crystal cell respectively). Scattered light (o-wave or e-wave) was almost completely depolarized in 3 mm and thicker crystal cells. Transmitted light was attenuated, evidently also due to some molecular scattering, but not significantly polarized. Inhomogeneities in a liquid crystal were induced with the aid of Co-Sm magnets, the focal length of the thus simulated astigmatic lens depending on the length of crystal treatment with the magnetic field and being varied accordingly over the 5-15 cm range. This treatment of the crystal cell had evidently no effect on the transmitted o-wave. Disclinations inside a thick cell exposed to a wide laser beam appeared immediately after the cell had been filled with a nematic liquid crystal, but within hours or days most of them or all them disappeared. The 180° phase shift, theoretically occurring upon passage of an o-wave from different sides of a disclination was verified by three optical methods: 1) comparing the recorded distribution of o-wave light intensity close behind a disclination with theoretically predicted Fresnel diffraction of its electric field by this disclination, 2) conventional interferometry using only linear optics, 3) with second-harmonic radiation of a pulsed YAG:Nd laser, the crystal cell having been placed between two nonlinear (KTP) crystals. The results confirm the theoretical estimates. Figures 5; references 4.

Experimental Research on Sedimentation Stability of Fractal Clusters

927J0205A Moscow KHIMICHESKAYA FIZIKA in Russian Vol 11 No 4, Apr 92 (manuscript received 13 Feb 91) pp 571-576

[Article by Ye. F. Mikhaylov and S. S. Vlasenko, St Petersburg State University; UDC 538.91]

[Abstract] A method is proposed for obtaining fractal clusters with a high sedimentation stability based on separation of the mechanisms of aggregation of primary aerosols. The design and functioning of an electrodiffusion separator is described. Its use makes it possible to enrich the initial aerodisperse phase by clusters of an anisotropic form and at the same time to reduce to a minimum the concentration of individual nuclei, which provides the necessary conditions for obtaining rarefied structures. Measurement data are used in determining the rate of gravitational sedimentation, density and aerodynamic radius as a function of the fractal dimension and gyration radius of the clusters. An experiment for determining sedimentation stability of fractal clusters is described in which the rate of their gravitational settling was ascertained. The size distribution of the settling particles was found by use of an electron microscope analysis. The research results indicate that the method for the generation of aerosol aggregates based on the separation of aggregation mechanisms, in combination with the preliminary modification of particles by an electrical field, makes it possible to grow fractal structures with different packing densities and this method can be used, in particular, to obtain dispersed systems with a high sedimentation stability. Figures 5; references 9: 7 Russian, 2 Western.

Some Properties of Energy-Insulated Coulomb Plasma. Computer Modeling of Microfields and Thermodynamic Quantities. The Problem of Ball Lightning

927J0235A Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 35 No 2, Feb 92 (manuscript received 3 Dec 91) pp 10-23

[Article by S. A. Mayorov, A. N. Tkachev, and S. I. Yakovlenko, Institute of General Physics, Russian Academy of Sciences; UDC 533.9]

[Abstract] The many-particle dynamics method (corpuscular dynamics method) is used to study the quasi-steady state of a classical Coulomb plasma. It is shown that the minimum characteristic time to establish both Debye screening and thermodynamic quantities in a classical Coulomb plasma is the average time for an electron to traverse the average distance between ions. The steady-state value of the energy of the Coulomb interaction of particles and potential around an immobile charge is described well by the Debye-Hückel theory even when less than one particle on average is in the Debye sphere. The distributions of instantaneous values of microfields in the plasma are obtained. The value of the trajectory traversed by an electron before it interacts with other particles that is obtained in the calculations and in quasibinary theory are compared. An attempt is made to link the anomalously long lifetime of the plasma of ball lightning with the slowing of the recombination rate of a classical Coulomb plasma in the absence of a stochastic effect. Unresolved issues pertaining to ball lightning are discussed. Figures 7; references 24 (Russian).

Optimum Finite Windows for Reconstruction of Images

927J0252A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 322 No 3, Jan 92 (manuscript received 9 Dec 91) pp 498-500

[Article by V. A. Afanasyev, V. F. Kravchenko, V. A. Rvachev, and Academician V. L. Rvachev, Ukrainian Academy of Sciences, Scientific Research Institute of Precision Instruments, Moscow; Kharkov Institute of Aviation imeni N.Ye. Zhukovskiy; UDC 621.391]

[Abstract] The authors' new method of reconstructing images with the aid of finite deconvolution windows, linear combinations of products of shifts of atomic functions, is extended to formation of windows under more general constraints. The problem of image reconstruction is accordingly reduced to finding, in a linear system with a weight function K(x,y) in the $L_1(R^2$-space, the deconvolution window W(x,y) which will extract the estimate e(x,y) of an input signal $s_i(x,y)$ from the output signal $s_o(x,y)$. The output signal $s_o(x,y)$ is represented as a convolution of $s_i(t,h)$ and K(x-t,y-h), plus an additive random noise N(x,y). The estimate e(x,y) is represented as a convolution of $s_o(t,h)$ and W(x-t,y-h) without noise. The constraints in the problem are: 1) both input signal and noise are mutually independent random uniform fields with zero mean and known spectral density each; 2) each spectral density as a function of two variables λ_1,λ_2 has continuous third derivatives with respect to both; 3) the window W(x,y) is a finite function which has continuous third derivatives with respect to both variables x,y and a quadratic carrier Ω= supp W = [-A,A] X [-A,A] (A > 0); 4) both weight K(x,y) and window W(x,y) are even functions of x and y. The unknown window W(x,y) is found by minimizing a functional I(W) equal to expectation of the sum of three squares of differences: 1) square of e(x,y)- $s_i(x,y)$; 2) square of difference between their first derivatives with respect to x, multiplied by factor γ; 3) square of difference between their first derivatives with respect to y, multiplied by factor γ. Such a formulation of the functional including the first derivatives accounts for the contrast characteristics of images to be reconstructed. Introduction of the Fourier transforms $K_1(\lambda_1,\lambda_2$ of K(x,y) and W_1 (λ_1,λ_2) of W(x,y) reduces the functional I(W) to a double integral in the R^2-space of functions of these two variables, functions which in the linear Γ-space have a carrier Ω and are finite even functions of x,y whose third derivatives with respect to both these variables are continuous. Defining the norm in the Γ-space by the norm in $L_2(R^2)$-space makes this functional differentiable in the Frechet sense. A minimum I(W) implies that the differential $L_W\varepsilon$= 0 for all ε(x,y). For the optimum window W(x,y) is then obtained a two-dimensional Fredholm integral equation of the first kind involving a double integral over the Ω-space of variables x,y with a continuous kernel M(x-t,y-h) such that M(x,y)= M(-x,-y). Solution of this equation is an ill-conditioned problem and, therefore, requires regularization. In the case of a white noise N(x,y) so that γ = 0 the optimum deconvolution window W(x,y) is found by minimizing the functional I(W), which now consists of the first sum of squares only. With appropriate constraints on W(x,y) and on the spectral density of the input signal, a two-dimensional Fredholm equation of the second kind will be obtained for the optimum window. References 6.

Chaotic Dynamics of Parametrically Excited Oscillators

927J0239A St Petersburg ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 12, Dec 91 (manuscript received 11 Feb) pp 1-11

[Article by D. M. Vavriv, V. B. Ryabov, and I. Yu. Chernyshov, Radio Astronomy Institute, Kharkov]

[Abstract] This article studies the interaction of an external signal with pump oscillations in parametrically excited oscillators. It is established that in such oscillators a stochastic instability may be developed even in a quasilinear excitation mode. This is accompanied by a substantial reduction of the threshold of the onset of chaos. The conditions of excitation of stochastic oscillations are determined in the framework of the Melnikov method. The scenarios for the generation of strange attractors and the rules governing

their evolution are studied. The stability of one-circuit parametric generators (transducers) is experimentally studied and a total correspondence of experimental and theoretical results is shown over a wide range of parameter changes. It is shown that typical modes for parametric generation and transformation of oscillations are unstable to the resonant effect of an external harmonic signal of relatively low intensity. A characteristic of the dynamics of a nonautonomous parametrically generated oscillator is multistability, which is manifested in the simultaneous coexistence and interaction of several attractors of different types (regular and chaotic). Figures 8; references 12: 7 Russian, 5 Western.

Ball Lightning as Quantum Condensate

927J0141A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 320 No 5, Oct 91 pp 1103-1106

[Article by A. V. Kulakov, corresponding member, USSR Academy of Sciences, and A. A. Rumyantsev, Leningrad State Technical University; UDC 537.52]

[Abstract] A ball lightning and the physical state of its substance are analyzed from the standpoint of quantum theory, formation of such a lightning being attributed to action of long-range quantum forces in a dense and cold but not degenerate plasma. As the plasma temperature decreases, the de Broglie wavelength of thermal electrons becomes much smaller than the interionic distance. Attendant interference of force centers results in an overlap of the wave functions of these electrons. The action of quantum forces generated by this overlap results in a collective "cohesion" of particles and eventual formation of a plasma condensate with characteristics of a liquid, which include surface tension. The energy of such a system decreases in the process, as the excess energy is being emitted, but the electromagnetic plasma interactions are retained. This mechanism of a ball lightning is demonstrated on a model system of N potential wells as force centers with a U_0 deep rectangular potential profile and a spherical geometry, with a radius ρ each, forming an array with a mean center-to-center distance b. Each well is assumed to be sufficiently shallow to cover only a continuous energy spectrum, without discrete energy levels when isolated from other wells. The entire array of force centers and particles subject to them is assumed to reside within a sphere with a radius $R >> \rho$. Each electron is assumed to be in an s-state, while also being in the state of a continuous spectrum with a wave number $k < 1/b$. Considering that the state of each particle in any one force center is influenced by the other N-1 centers, their action on it is treated as a perturbation. In accordance with the requirement that the wave vector of the system have commutative symmetry, the interparticle interaction energy is then described by the expression $E^1 = (\Psi| \hat{V}|\Psi)/(\Psi|\psi)$ ($\Psi = \hat{A}\Phi$, $\hat{A}$- symmetrization operator which extracts some Young scheme for the coordinate part of the state vector, $\Phi = \Pi_i \psi(r_i)$- direct product of wave functions associated with each potential well, r_i- distance from i-th center, $\hat{V} = \Sigma_{k \text{ not } i}^{N} u(r_k)$, $u(r_k$- potential at the k-th center). This energy consists of two parts: $E_d^{(1)} \approx -2NV_{U0}n\rho^3$ representing direct interaction and $E_e^{(1)} = -NU_0(\rho/b)^6 nv_m$ representing exchange interaction (N- number of force centers, V- volume of sphere, $n = N/V$, $v_m = 4\pi(2\pi\lambda)^3/4$, de Broglie wavelength $\lambda = 1/k$). The criterion for exchange interaction predominating over direct interaction is accordingly $(2\pi\rho\lambda/b^2)^3 > 1$ (λ- de Broglie wavelength), which reduces to $\pi\lambda > b$ when the potential wells are contiguous to one another so that $b = 2\rho$. These relations are applied to a plasma which is not degenerate but satisfies this inequality, whereupon the state of the lightning plasma is estimated on the basis of observations. Measurements have yielded, after statistical analysis, the following average values of plasma parameters: temperature about 1000 K, ion charge $z \geq 1$, particle concentration $n = 2 \times 10^{19}$ cm^3, de Broglie wavelength $\lambda = 1$ nm, mean interionic distance $d = 3$ nm. According to these data, the plasma of a ball lightning plasma can exist in the state of a quantum condensate. References 6.

Fractal Contact Between Solid Bodies

927J0157A Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 9, Sep 91 (manuscript received 15 Oct 90) pp 50-54

[Article by F. M. Borodin and A. B. Mosolov, Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow]

[Abstract] The effect of surface fractality on the characteristics of contacts between solid bodies analyzed, considering as a typical example a rigid steel punch with a rough surface pressing into a medium occupying a half-space with a smooth surface prior to impact. The analysis is based on selection of a Cantor set as the simplest model of a fractal surface. Assuming a surface roughness produced by self-similar scratches, the "imprint" of the rough punch surface on the half-space with extrudable material is obviously a fractal of dimensionality $D_0 = 1 + D_C$: direct product of a Cantor set of dimensionality $D_C = (\log 2)/(\log 2C)$ and a straight line or segment. The rough punch surface is also a fractal, as demonstrated by calculation of the length of its contour: $L_{(n)} = L + 2h(q^{n+1} - 1)/(q - 1)$ after n iterations to include n successive generations ($q = 2/j$, L- width of punch, h- depth of deepest depression). Pressing a fractal punch into a half-space is treated as a contact problem to be solved for the driving force as a function of the displacement depth. For a half-space with material which fits the model of a rigid-plastic body with the plastic limit in shear, an exact analytical solution in the form of a power-law force on displacement dependence is obtained with the aid of Hill's solution for a punch with a flat base. For a half-space with material which fits the model of an elastic body, an analytical solution in closed form has not yet been obtained on the basis of conventional theory of elasticity. An exact solution can, however, be obtained on the basis of a simpler model of an elastic half-space. Such a solution, also in the form of a power-law force on displacement dependence is obtained for the model of a Winkler base. Figures 4; references 17.

Quadratic Algebras and Dynamics in Curved Space, Part 2: Kepler's Problem

927J0241A Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 91 No 3, Jun 92 (manuscript received 6 Aug 91) pp 396-410

[Article by Ya. I. Granovskiy, A. S. Zhedanov, and I. M. Lutsenko, Donetsk State University]

[Abstract] Random degeneracy dynamics of Kepler's problem in a curved space with constant negative curvature is considered, the symmetry algebra being shown to reduce here to the quadratic Racah QR(3) algebra with the Casimir operator. The overcoupling coefficients for wave functions in spherical coordinates and in parabolic coordinates are correspondingly expressed in terms of Wilson-Racah polynomials. A flat space becomes the limiting case and parabolic coordinates are shown not to exist in a curved space with positive curvature. It is also shown that the here spectrum generating algebra coincides with the quadratic Jacobi QJ(3) algebra. With its real operators it is possible to explicitly express the wave functions of this problem, beginning from the ground state. References 22.

Simplest Nonlinear Problems

927J0152A Minsk DIFFERENTSIALNYYE URAVNENIYA in Russian Vol 28 No 1, Jan 92 (manuscript received 21 Aug 91) pp 52-59

[Article by A. A. Lezin, Institute of Mathematics imeni V. A. Steklov, USSR Academy of Sciences; UDC 517.984]

[Abstract] Solvability of boundary-value problems for the equation $L_\lambda = (D_t - \lambda)u = F(t,u)$ is considered: u(t)- complex function of real variable $t \in [0,b]$, $0 < b < \infty$, $\lambda \in C$, and F(t,z)- complex function over [0,b] X C. The boundary conditions are $\mu u|_0 - u|_b = 0$, with $0 \leq \mu \leq \infty$ ($\mu = \infty$ means $u|_0 = 0$). An analysis of the family of explicit solutions reveals how the mode of solving these problems, whether directly according to the theory of implicit functions in its abstract form or directly by the method of successive approximations for regular values of the "spectral" parameter λ within the neighborhood which corresponds to the problem for the linear equation $L_\lambda u = (D_t - \lambda)u = f(t)$, depends on the values of this parameter λ and thus how its "critical" values relate to the spectrum of this linear equation. The analysis reveals also how the periodic case $\mu = 1$ fundamentally differs from the aperiodic cases μ not equal to 1 (except $0,\infty$) and how the increase of function F with respect to u influences the structure of the solution. Problems for nonintegrable equations such as the equation $L_\lambda u = (D_t - \lambda)u = u^2 + \varepsilon f(t,u)$ with a small parameter ε are tackled by the method of perturbation theory and the family of its solutions is examined as systematically as has been done before. References 3.

Determining Likeness Between Image and Similarity of Microparticle Size Distribution in Dispersed Medium

927J0209A Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 34 No 12, Dec 91 (manuscript received 24 May 91) pp 80-84

[Article by V. I. Psarev, Zaporozhe State University; UDC 548.3:548:536.4]

[Abstract] A method is proposed for determining the likeness and difference between the experimental distribution of microparticles of a dispersed system using their size as the key criterion and the corresponding distribution (similarity) selected from among theoretical distributions with positive and negative asymmetry. The groundwork for this method was laid by the author in an earlier article (IZV. VUZov. FIZIKA, No 12, pp 53-58, 1990). The objective of the comparison is the extraction of necessary information on the nature of transpiring of internal processes in the dispersed system evolving due to reactive Ostwald coagulation of microparticles. The procedure of comparison of distributions is illustrated in the example of a histogram of dispersed Al_3Mg_2 particles of an aluminum-manganese alloy isothermically heated at 430°C. With non-zero values of the key parameters α and ε (introduced in the earlier study) the dissolution and growth of Al_3Mg_2 particles during heating of the melt are dependent to a definite degree on the individual properties of the microparticles at the interphase boundary: on the degree of equilibrium and nonequilibrium conditions prevailing there and the rate of reaction with magnesium and aluminum atoms. On the basis of the nature of change in the values of these parameters during the time of isothermic heating of the melt or using the temperature function it is possible to judge the kinetics of processes at the interphase boundary. References 8: 6 Russian, 2 Western.

Solvability of Nonlinear Boundary-Value Problem in Fixed Set of Functions

927J0170A Minsk DIFFERENTSIALNYYE URAVNENIYA in Russian Vol 27 No 12, Dec 91 (manuscript received 28 May 90) pp 2027-2033

[Article by S.A. Brykalov, Institute of Mathematics and Mechanics, Ural Department, USSR Academy of Sciences; UDC 517.927]

[Abstract] A boundary-value problem for a nonlinear m-order functional differential equation $x^{(m)}t) = F(x(.))(t)$ ($t \in [a,b]$) with k= 0,...,m-1 nonlinear boundary conditions $B_k(x^{(k)}(.)) = 0$ (k-th boundary condition not containing derivatives of orders lower than k). The solution $x(.) \in CL_1^m([a,b]),R^n)$ must satisfy this equation almost everywhere, $|\cdot|_n$ denoting the norm of n-dimensional R^n space. An existence theorem for at least one solution in a fixed set of functions is, along with with two auxiliary statements, proved with the aid of a lemma and Schauder's fixed point principle. This theorem is then extended, in the form of a corollary and another auxiliary statement, to two sets within the intersection of which the problem is not solvable. An example of such a problem is one with nonlinear boundary conditions for the scalar nonlinear second-order differential equation $d^2x/dt^2 = f(t,x,dx/dt)$ where $t \in [a,b]$, $\|x(.)\|c^o = g_0(x(.))$, $\|dx/dt(.)\|c^o = g_1(x(.))$. The corollary is proved by demonstrating that any solution to this problem cannot possibly belong simultaneously in two classes of functions and, therefore, this problem has at least four solutions. References 9.

Synthesis of Control for a System With Nonlinear Resistance

927J0104A Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 55 No 6, Nov-Dec 91 (manuscript received 19 Mar 91) pp 883-894

[Article by F. L. Chernousko, Moscow; UDC 531.36:62-50]

[Abstract] A feedback control U(q,dq/dt) is synthesized for a dynamic system, a body moving through a medium, describable by the equation $md^2q/dt = R(dq/dt) + U +$

V(q,dq/dt,t) (q- generalized system coordinate, m- constant mass, R-resisting force a function of dq/dt, V-perturbing force a function of q, dq/dt, and time t). The resisting force is a drag which increases with increasing velocity of the body and becomes zero for the body at rest, R(dq/dt) being a smooth function. The control force U and the perturbing force V are subject to geometrical constraints, with $U_{max} >> V_{max}$ and the control force U required to return the system to its initial state. The equation, upon normalization of variables including $R/U_0 = -f$, is transformed into the dimensionless equation $d^2/dt^2 = f(dx/dt) = u + v(x,dx/dt,t)$. The problem is treated as a differential game played by two opponents under constraints, $u = U/U_0$ and $v = V/V_0$ representing their respective controls. A position control u(x,dx/dt) is sought which will transfer the system from the state $x(0) = \xi$ and $(dx/dt)(0 = \eta$ to the state $x(T) = 0$ and $(dx/dt)(T) = 0$ in the minimum guaranteed finite time T under any tolerable perturbation v. The problem is thus reduced to synthesis of a control with optimum speed under those conditions. It is solved as such by application of the maximum principle to its Hamiltonian $H = p_1x_2 + p_2[(1-\rho)u - f(x_2)]$ (p_1,p_2 coupled variables, $dp_1/dt = 0$, $dp_2/dt = -p_1 + f(x_2p_2$, $\rho = -v/u$). It is proved, by reductio ad absurdum, that each optimum trajectory contains only one point where $p_2(t) = 0$, thus only one point of control switching, and that cannot include a segment where $p_2(t) < 0$. The solution of the control problem simplifies when the perturbation, which heretofore not assumed to be known but its maximum possible magnitude having been stipulated, will be completely ignored. A comparative analysis of phase trajectories indicates that game method of solving the problem will yield a feedback control which guarantees the return of such a system to its initial position under conditions of any drag nonlinearity and any perturbation v smaller than the control u. Ignoring the perturbation is shown to yield a more restrictive solution to the problem, a return to the initial position then being possible only when $v < 0.618u$ and being impossible when $v > 0.618u$. Figures 3; references 6.

Steady and Reducible-to-Steady Modes in Normal Stochastic Differential Systems

927J0104B Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 55 No 6, Nov-Dec 91 (manuscript received 27 Dec 90) pp 895-903

[Article by N. K. Moshchuk and I. N. Sinitsyn, Moscow; UDC 531.36]

[Abstract] A normal stochastic differential system is defined as one whose state is describable by Ito's stochastic differential equation $dZ/dt = A(Z,t) + B(Z,t)V$, $Z = Z_0$ at time $t = 0$. Here: Z member of set R^k is the generally expanded state vector, $a = a(Z,t)$ and $b = b(Z,t)$ are determinate functions of both kx1-dimensional variable Z and kxl- dimensional variable t, V(t) is the l-dimensional vector of mutually independent normally distributed white noise processes with zero expectation values and with an lxl-dimensional intensity matrix $v = gn(t)$ (time derivative of a Wiener process). Such a system is steady when the intensity v of white noise processes is constant in time and A,B are not functions of time. Such a system is reducible to a steady one when there exists a smooth reversible change of state variables which, independently of the argument, transforms the system to a steady one in the new variables. The problem of finding exact expressions for one-dimensional distributions of steady (in the narrow sense) modes and of reducible-to-steady modes is tackled by considering that the one-dimensional density $f = f(z,t)$ of a random process Z(t) in a steady stochastic differential system satisfies the Fokker-Planck-Kolmogorov equation with the normalization condition and the appropriate initial condition. Seven theorems are proved stating when and only when a function $f = f(z,t)$, scalar function N(z) representing density of finite invariant measure of quiescent system $dz/dt = a_1(z)$, and function $f = ce^{-F}$ (F- first integral of quiescent system) will be one-dimensional and satisfying that equation. The problem of finding steady distributions is thus reduced to finding the distribution density f of an invariant measure of a quiescent system. On this basis are analyzed first the constrained motion of a system of material points in a uniform field of random accelerating forces, in a Cartesian system of coordinates, and then the dynamics of holonomic systems with random perturbations of the normal white noise kind. Two additional theorems pertain each to existence of a different matrix function and of a scalar function which satisfies three requirements, two of them different in each case, as the condition when and only when an Ito stochastic differential system admits a nonsteady distribution reducible to a steady one. References 6.

Asymptotic Form of Solutions of Some Nonlinear Equations With t Tending to Infinity

927J0231A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321 No 2, Nov 91 (manuscript received 23 Sep 91) pp 290-293

[Article by P. I. Naumkin and I. A. Shishmarev, Moscow State University imeni M. V. Lomonosov; UDC 517.9+535.5]

[Abstract] This is a continuation of a previously published series of articles by the authors (MAT. ZAMETKI, No 4, pp 118-121, 1989; MAT. MODELIR., Vol 1, No 6, pp 109-125, 1989; IBID., Vol 2, No 3, pp 75-88, 1990) devoted to research on asymptotic forms with large times of solutions of the Cauchy problem for different nonlinear dissipative equations. Two equations are examined: OSO (E. Ott, et al., INT. J. NONLINEAR MECH., Vol 11, pp 401-416, 1976) and BBMB (C. J. Amick, et al., J. DIFFERENT. EQUATIONS, Vol 81, No 1, pp 1-49, 1989). The first of these equations is equivalent to the well-known Korteweg-de Vries (KdW) equation if $\lambda = 0$ and $\omega = 0$. However, in this study it is assumed that λ and ω do not simultaneously become equal to zero (weak dissipation is added to the KdW equation). A case of special interest is when $\omega = 0$, $\lambda > 0$,

when this equation is transformed into the KdW equation with linear dissipation. Although many studies of this equation have been made, the coefficient $\lambda > 0$ is considered a small parameter. The theory of perturbations is applied for the small parameter λ and the inverse scattering problem method is used for the KdW equation. With such an approach it is only soliton initial conditions and small λ which are studied and the case of quite general initial perturbations and finite λ is not examined. Another important shortcoming of earlier studies is the absence of evaluations of the residual terms in the asymptotic formulas, so that the range of applicability of the asymptotic forms obtained is indeterminate. A proper solution of this problem is presented; the mentioned inadequacies are overcome. A similar examination of the second equation also is made and a proper solution is obtained for this case as well. References 13: 5 Russian, 8 Western.

Self-Similar Solutions to Leybenzon's Equation

927J0150A Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 5, Sep-Oct 91 (manuscript received 1 Dec 88) pp 145-150

[Article by M. V. Kachan, S. F. Pimenov, S. M. Sushchiy, and M. B. Entel, Rostov-na-Donu; UDC 532.546]

[Abstract] The one-dimensional equation of plane diffusion with a power-law concentration dependence of the diffusion coefficient or plane heat conduction with a power-law temperature dependence of the thermal conductivity is reduced to Leybenzon's equation $c^2\delta\theta/\delta t = \delta^2\theta^k/\delta z^2$ (k= n+ 1, n- exponent of power law), the solutions to this equation being self-similar for a semi-infinitely long path $z \geq 0$ in a medium with the initial condition $\theta(z,0)= \theta_1 = \text{const} > 0$ and either one of the two boundary conditions $\theta(0,t)= \theta_2 \geq 0$ $(t > 0)$ or $\delta\theta^k(0,t)/dz = \psi(t)$ $(t > 0)$. This equation is solved, approximately, by Barenblatt's method pertaining to filtration of a liquid or to polytropic expansion of a gas, for an arbitrary monotonic function of time $\psi(t)$ and under two different constraints: a) "outward" flow, b) $k \geq 2$ so that the equation becomes a strongly nonlinear one. When $\theta_2= 0$, then the equation describes "drainage of a basin". When k= 2, then the equation becomes Boussinesq's equation for a boundary layer on a flat plate and this equation has alredy been solved. Figures 3; references 6.

Flipping-Over Solitons, Part 4: Extension of Systems of the Hydrodynamical Kind

927J0125A IZVESTIYA AKADEMII NAUK SSSR: SERIYA MATEMATICHESKAYA in Russian Vol 55 No 5, Sep-Oct 91 (manuscript received 6 May 91) pp 991-1006

[Article by O. I. Bogoyavlenskiy; UDC 517.91]

[Abstract] Having earlier derived a system of equations of the hydrodynamical kind which is related to the Volterra system of equations and includes the discrete two-dimensional Korteveg-deVries equation (IZVESTIYA AKADEMII NAUK SSSR: SERIYA MATEMATICHESKAYA Vol 55 No 3, 1991), the author derives a more general system of equations representable in the Lax form and includes that hydrodynamical kind of a system as a special case. First is considered the Lax equation $(L+ \alpha\delta_y)_t = [L+ \alpha\delta_y, \gamma L^2/\alpha + A]$ with the Jacobi operator L, where matrices L and A have only $L_{i,i+1} = L_{i+1,i} = a_i$ $(L_{ii} = p_i)$ and $A_{i,i+1} = -A_{i+1,i} = x_i$ (A_{ii}) nonzero elements respectively. The matrix equation $L_t = \gamma(LL_y+ L_yL) + \alpha A_y + [L,A]$ is expanded into a system of equations which reduces to the original hydrodynamical system when $\alpha = 0$ and coincides with the two-dimensionalized Toda chain when $\gamma = 0$. Next is considered the matrix equation $L_t = LL_yL + L^2L_zL^2 + [L,A]$ with the Jacobi operator L, where the skew-symmetric matrix A has nonzero elements $A_{i,i+2} = -A_{i+1,i} = x_i^0$ and $A_{i,i+4} = -A_{i+4,i} = x_i^2$ elements. A simple construction of hydrodynamical systems of equations each containing a numerous set of pointwise first integrals with respect to space variables is demonstrated, starting with the matrix equation $L_t = [L, \Sigma_{k=1}^n(A_k)_{yk}]$ where $A_k = A_k(L)$. The construction is demonstrated on three new systems of operator equations which include the Jacobi operator L along with operators A and B. All of them, upon appropriate multiple substitutions and replacement of the $[A,B] = 0$ equation with the equivalent zero-curvature equation $A_{1y} - B_{1t} = [A_1, B_1]$, reduce to an explicit but unwieldy form of differential operator equations. These in turn lead to a system of two equations, one of them necessarily being the equation of commutativity for $[A,B] = 0$ or that zero-curvature equation. Two examples of two-dimensional commutative differential operators $A = -\tau_t - A_1$ and $B = -\tau_y - B_1$ containing arbitrary functions of two variables are shown, operators $A_1(t,y)$ and $B_1(t,y)$ belonging in some simple Lie algebra G are shown. Another equation representable in the Lax form $L_t= [L,A]$ is the Kadomtsev-Petviashvili equation $(u_t- 6uu_x+ u_{xxx})_x = -3\alpha^2u_{yy}$. This equation in the Lax form becomes the condition of compatibility for a linear system of four equations $[a,c] = 0$, $[U,a] + [c,b] = 0$, $b_x = [U,b] + c,V] + cb_y - 2aU_y$, $U_t - V_x + [U,V] = aU_{yy} + bU_y - cV_y$ with constant a-matrix and c-matrix. The equation N(inft = NR - R [dash over R] N, a special case of L - A - B triad equations (N,R- complex operators) is shown to be reducible to a system of two equations $L_t = [L,A] - (M,B)$ and $M_t = (L,B) + [M,A]$ involving the anticommutator $(M,B) = MB + BM$, whereupon the system of two equations $L_t = [L,A] - \mu(MB + \sigma BM)$ and $M_t = [MA] + \sigma LB + BL$ equivalent to the Lax equation $\Lambda_t = [\Lambda,A]$ is shown to be reducible to an equation representing the multidimensional nonlinear generalization of a harmonic oscillator. Dynamical systems representable in the Lax form and generalizing the Toda chain are shown, also a new integrable Euler equation $L^{\cdot} = [L,A_n$ and a more general Euler equation $L^{\cdot}= [L,\Sigma_{j=1}^m (\alpha_jL\beta_j+ \beta_{jL\alpha_j}) + A_n]$ in the Lax representation. References 12.

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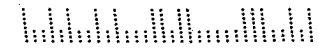

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